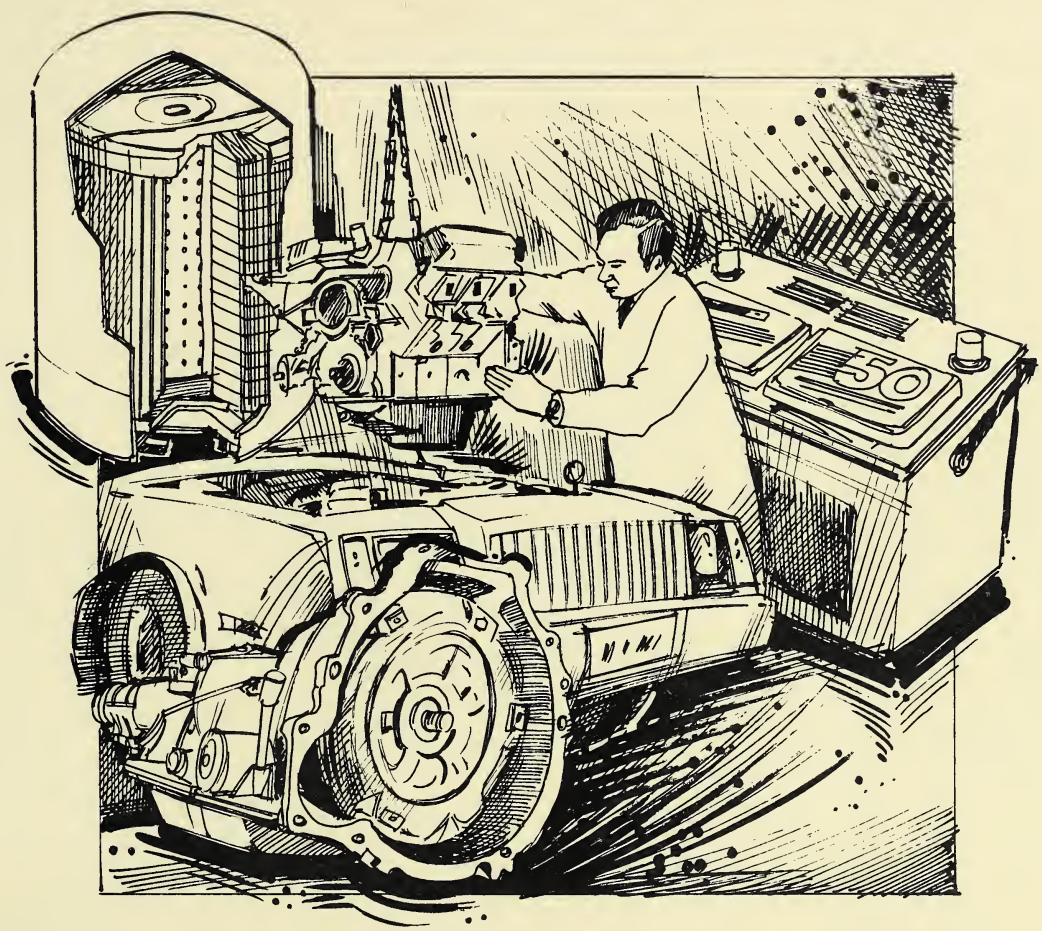
AUTOMOTIVE SERVICES 26



STUDENT WORKBOOK

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EDUCATION

Automotive Services 26

Student Workbook

Grade 11

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JOB SHEETS

JOB SHEETS (continued)

Use Appendix 4: Job Sheet Evaluation Chart to monitor your own performance and have your teacher/supervisor and a classmate evaluate your performance each time you complete a job.

STUDENT SAFETY PLEDGE FORM

_____, who is enrolled in Automotive Services 26, will, as a part of the learning experience, operate equipment and tools, providing written parental/guardian permission is given.* Each student will be given proper instruction, both in the use of the equipment and tools and in correct safety procedures, before being allowed to work alone. Because the student must assume responsibility for following safety practices, we ask that he or she subscribe to the following safety pledge.

- I WILL FOLLOW ALL SAFETY RULES.
- I WILL NOT ASK PERMISSION TO USE AN ITEM OF EQUIPMENT OR TOOL UNLESS I HAVE BEEN INSTRUCTED IN ITS USE.
- I WILL REPORT ANY ACCIDENT OR INJURY IMMEDIATELY TO THE TEACHER/SUPERVISOR.

DATE _____ STUDENT'S SIGNATURE _____

I hereby give my consent to allow my son or daughter to operate all equipment and tools necessary to carry out the tasks in this course.

DATE _____ PARENT'S/GUARDIAN'S SIGNATURE _____

Parents/Guardians are cordially invited to visit and arrange to view any tasks performed by the students.

* Parental/Guardian's consent is necessary only if the student is a minor.

INTRODUCTION

Welcome to Automotive Services 26!

The automotive industry is continually growing and changing every year. Entry-level employees can develop a lifelong career in this area with the right qualifications.

Automotive Services 16 introduced you to the industry and gave you a starting point for gaining new skills and knowledge. Automotive Services 26 will provide extra time for you to build on your skills and knowledge while allowing you to complete more challenging tasks.

Course activities include:

- basic vehicle maintenance
- vehicle testing
- fuel system maintenance
- brake system repair
- tire diagnosis and maintenance.

To find out more about what you will be taking in this class, study Appendix 1: Automotive Services 26 Profile at the back of the workbook.

SAFETY IS EVERYONE'S BUSINESS

The proper and safe use of equipment, tools and supplies protects you, others and property in both the school lab and in the workplace.

Job sheets in this workbook contain safety information (e.g., safety rules, practices, cautions, protective clothing/gear) where appropriate.

SAFETY PRACTICES AND PROCEDURES MUST BE FOLLOWED

NOTE: Safety practices may vary in different situations. **Always follow your teacher's/supervisor's instructions.**

STUDENT ACTIVITIES

Discuss and answer the following questions:

1. What did you most enjoy learning in Automotive Services 16? Why?

   _____

   _____

   _____

2. What does a service technician do? _____

   _____

3. How are apprentices trained? _____

   _____

4. How long is a "Motor Mechanic" apprenticeship? _____ years.

5. What can the VIN number be used for? _____

   _____

6. What is the purpose of each of the following items:

   - torque wrench? _____

     _____

   - fasteners? _____

     _____

   - jack stands? _____

     _____

   - coolant? _____

     _____

   - lubricants? _____

     _____

   - pistons? _____

     _____

7. Why is the measurement of parts an important part of an automotive technician's work?

_____

_____

_____

8. Match each of the following terms with its proper description:

Maintenance	Tune-Up
Overhaul	After Market Products
R & R	Rebuilt Parts
Troubleshooting	Detailing
Dealership	RPM

1. _____ – A part or product that is installed after the vehicle has been assembled by the manufacturer.

2. _____ – Diagnosing or finding out what has caused a vehicle fault.

3. _____ – Remove and replace, taking off a component and putting a component back on.

4. _____ – To make a used component like new again by part replacement, machining and adjustment.

5. _____ – Regular procedures done to vehicles to make them last longer and operate correctly.

6. _____ – Components that have been overhauled by a company that specializes in that type of work.

7. _____ – Maintenance, repairs and adjustments made to fuel and ignition systems to keep the engine running properly.

8. _____ – Cleaning a vehicle inside and out to make it look its best.

9. _____ – A business that sells vehicles.

10. _____ – Revolutions per minute.

JOB SHEET 1
COLLECTING AUTOMOTIVE JOB ADVERTISEMENTS

EQUIPMENT, TOOLS AND SUPPLIES

- Newspapers
- Workbook
- Tape
- Scissors

PROCEDURE

1. Collect several job and career sections from classified advertisements in local newspapers.

2. Cut out any job advertisements related to the automotive industry.

3. When the collection is complete, sort the advertisements into different job categories, such as manager, parts person, mechanic's helper.

4. Attach the job advertisements to the following page. Remember to keep the categories separate from one another and arrange the cutouts neatly.

5. Share your collection with your classmates and note the variety of automotives jobs that are available.

6. Clean and return all equipment, tools and supplies to their proper storage areas.

7. Clean up the work area.

8. Using the following chart as a guide, evaluate your performance.

	Excellent 4	Very Good 3	Good 2	Not Acceptable 1
All steps in the procedure were completed.				
All advertisements in the collection were automotive related.				
The advertisements were properly categorized.				
The collection was neatly presented.				
The equipment, tools and supplies were cleaned and returned.				
The work area was cleaned up.				

DISCUSSION TOPICS

1. Where else can people find out about job opportunities in the automotive industry?

2. What is the average wage range for an entry-level employee in the automotive industry?

3. What is the average wage range for a journeyman motor mechanic?

SAFETY

Auto shop safety is everyone's business regardless of whether working at home, in school or in industry. This means it is important that everyone understands the basic rules of safety:

- Do not use any tool, machine or supply item unless you know how to use it properly.
- Obtain your teacher's/supervisor's permission before using a machine.
- Wear the safety equipment required for the job. Your teacher/supervisor will explain when you need to wear safety glasses, vinyl gloves, full face shields, etc.
- Use tools only for the purpose for which they were designed. The wrong tools or improper usage can hurt you and damage parts.
- Horseplay and practical jokes are not permitted in the work area at any time.
- Report any hazards. If you see something that could cause injury, let your teacher/supervisor know about the problem. If possible, get another student to keep others away from the hazard while you are informing the teacher/supervisor.
- Report all injuries, accidents and equipment malfunctions immediately to your teacher/ supervisor.

STUDENT ACTIVITIES

1. Safety practices may be divided into two categories, personal safety and general safety. In the chart below, list four personal and four general safety practices considered important in automotive shops.

SAFETY PRACTICES	
Personal	General
•	•
•	•
•	•
•	•

2. Discuss: "Why is safety in an automotive shop everyone's business?" Record major points from the discussion.

_____

_____

_____

_____

3. Visit a local automotive shop or invite an automotive mechanic to class to discuss shop safety practices. List the personal and general safety practices that each person in the shop is expected to follow.

Personal Safety Practices _____

_____

_____

General Safety Practices _____

_____

_____

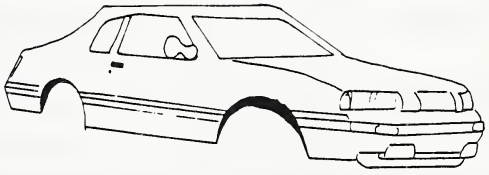
4. What procedures must be followed in the lab or in your workplace in the following circumstances:

- a worker's hand is cut? _____
  _____
- the fire alarm sounds? _____
  _____
- engine oil is spilled? _____
  _____
- a customer's vehicle must be put on a set of jack stands? _____
  _____

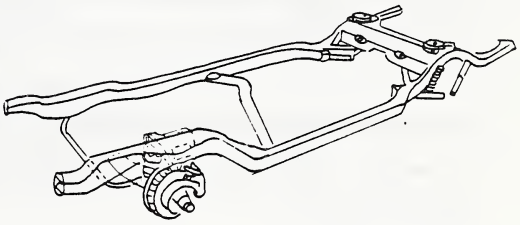
VEHICLE PARTS

Vehicles consist of three main parts:

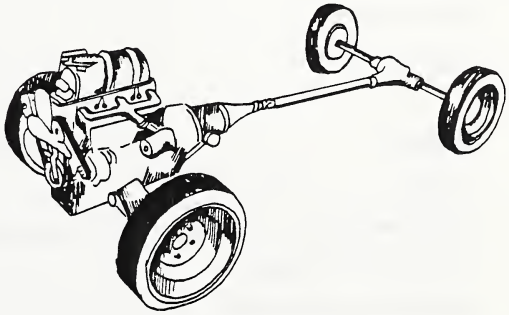
a. The Body – This is the exterior "skin" of the vehicle. The body covers all the parts of the vehicle and provides a place for the driver, passengers and payload to ride. This is also the part of the vehicle that may be changed every year by "styling" the vehicle to make it more attractive to customers.



b. The Chassis – The chassis is the skeleton of the vehicle. It includes the frame, suspension, and steering parts. It also holds together in correct "alignment" all the other parts of the vehicle. It must be rigid and strong to hold parts together and yet allow movement over rough spots in the road. In some vehicles with "unitized body" construction (e.g., Chevette), the reinforced sections of the body replace some or all of the frame.



c. The Power Train – The power train is a collection of parts used to move the vehicle down the road at the speed required. The power train is also called the drive train and includes the following parts: engine, clutch, transmission, drive shaft and rear axle assembly.



The modern vehicle is made up of over 10,000 parts. Automotive service workers should be able to name the major parts and many of the minor parts of any vehicle.

JOB SHEET 2
IDENTIFYING VEHICLE PARTS

EQUIPMENT, TOOLS AND SUPPLIES

- Repair manuals
- Owners' manuals or operators' manuals
- Parts books
- Vehicle
- Safety glasses
- Protective clothing
- Creeper
- Trouble light

PROCEDURE

1. Form a group with one or two other students from your class.

2. **Put on the protective clothing and safety glasses.**

3. Using the reference materials, identify all of the 54 parts listed below. If you still cannot find a part, request help from your teacher/supervisor.

4. When you have identified all of the parts, have a partner test your knowledge of where each part is located. For every part you identify correctly, have your partner put a check mark in the appropriate box.

Body			
hood	☐	Front bumper	☐
trunk lid	☐	windshield	☐
left front door	☐	grill	☐
right rear fender	☐	rocker sill	☐

Chassis			
frame	☐	grease nipples	☐
left front tire	☐	steering box	☐
left rear leaf spring	☐	right rear shock absorber	☐
right front coil spring	☐	idler arm	☐
left lower control arm	☐	steering column	☐
left outer idler arm	☐	steering wheel	☐

Power Train

engine	☐	transmission oil dipstick	☐
transmission	☐	front universal joint	☐
drive shaft	☐	differential fill or level plug	☐
rear axle assembly	☐	drum brake unit	☐
engine oil dipstick	☐	disc brake unit	☐
engine oil pan	☐	rear brake hose	☐
engine oil filter	☐	gas or fuel tank	☐
radiator	☐	fuel pump	☐
engine fan	☐	radiator cap	☐
fan belts	☐	valve cover	☐
water pump	☐	gas cap	☐
distributor	☐	fan shroud	☐
air cleaner	☐	alternator	☐
battery	☐	muffler	☐
starter	☐	exhaust manifold	☐
lower radiator hose	☐	intake manifold	☐
brake master cylinder	☐	right motor mount	☐

Score: _____/54

5. Evaluate your performance by calculating the percentage of the parts that you were able to identify correctly.

$$\frac{\_\_}{54} \times 100 = \quad \%$$

6. Return all of the reference materials to their correct storage location.

7. Clean and return the creeper and trouble light to their proper storage areas.

SHOP PROCEDURES

Shop procedures refer to the tasks that people in the automotive industry do to keep a shop operating. Employers look for entry-level workers who are able to:

- take inventories
- identify product characteristics
- locate parts and suppliers
- identify and read shop references, specifications or repair instructions
- maintain shop equipment
- clean and maintain the shop area.

INVENTORIES

Taking inventory involves counting the stock of parts, shop supplies, tools and equipment and recording the information. Inventories are taken to:

- prevent running out of materials
- check the quantity and variety of stock on the premises
- verify the presence of purchased tools and equipment
- allow the owner to calculate regularly the worth of the business.

Many businesses now use computers to keep track of stock and prevent delays in performing automotive services due to lack of materials. Inventory checks may be done by hand. However, computers may be used to retain the information.

Accurate reading and recording of each part's number is important. Mixing two digits in a part number may indicate a completely different part. As an entry-level employee, accurate recording of information is an important skill.

Taking automotive parts inventories may involve:

- writing down the name of the item
- recording the complete part number (or model and serial number)
- counting the stock and recording the number on the inventory form.

e.g.,

Item Name	Part Number	Quantity in Stock

JOB SHEET 3
TAKING AN INVENTORY

EQUIPMENT, TOOLS AND SUPPLIES

- Pen or pencil

PROCEDURE

1. Use the charts below to take inventory of items in the lab or workplace. Use catalogues to help you identify product names, manufacturers, parts numbers and sizes.

AUTOMOTIVE SUPPLIES				
Item No.	Item Name	Manufacturer	Part Number/Size	Stock Count
Sample	Power Suds Soap	Qwik-Kleen Ltd.	1201 – 10 litre	3
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

AUTOMOTIVE EQUIPMENT					
Item No.	Item Name	Manufacturer	Model	Serial Number	Stock Count
Sample	Tire Changer	Coates	RC10-A	156374	1
1					
2					
3					
4					
5					

AUTOMOTIVE HAND TOOLS				
Item No.	Item Name	Manufacturer	Part Number/Size	Stock Count
Sample	Wrench	Handi-Tool	431 – 14mm	5
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

2. Using the following chart as a guide, evaluate your performance.

	Excellent 4	Very Good 3	Good 2	Not Acceptable 1
The sample inventories were completed.				
The writing was legible.				
The records were accurate.				
The proper names were used.				

DISCUSSION TOPICS

1. How often are inventories performed in local business?

2. How does an actual inventory form in industry vary from the forms you used in completing this job?

PRODUCT IDENTIFICATION

In your community, there may be more than one automotive supplier. Each supplier may sell similar items. However, these items may be made by different manufacturers. It is, therefore, necessary for automotive service workers to be able to locate and accurately identify and record details about each item.

Parts books and catalogues contain details of replacement items for each type of vehicle. The details include:

- manufacturer's name
- part number
- cost of part
- warranty.

STUDENT ACTIVITIES

1. Using a parts book, identify the mechanical parts and fill in the blanks for each of the following items: (If your shop does not have parts books in stock, outdated books may be available from local dealerships or parts suppliers.)

   a. Set of sparkplugs for a 1991 Lexus LS400 with a V8 engine
   Manufacturer – Lexus
   Part Number – _____
   Cost (list/retail) – _____
   Warranty – _____

   b. Water pump for 1980 Ford LTD with 351 CID-V8 engine
   Manufacturer – Ford Motor Company of Canada Ltd.
   Part Number – _____
   Cost (list/retail) – _____
   Warranty – _____

   c. Set of front brake pads for 1990 Dodge Shadow with 2.2 L engine
   Manufacturer – Chrysler Canada Ltd.
   Part Number – _____
   Cost (list/retail) – _____
   Warranty – _____

2. Visit a local parts dealer or department store and obtain details about the following shop supply items and fill in the blanks.

   a. Can of gasket cement (smallest size available)

      Size – _____

      Product Name – _____

      Manufacturer – _____

      Cost per unit – _____

   b. 5 cm hose clamp

      Product Name – _____

      Manufacturer – _____

      Cost per unit – _____

   c. 1.8 cm diameter heater hose

      Product Name – _____

      Manufacturer – _____

      Cost per metre – _____

   d. Spray can of orange engine enamel paint (smallest size available)

      Size – _____

      Product Name – _____

      Manufacturer – _____

      Cost per unit – _____

AUTOMOTIVE SUPPLIERS

Shops cannot stock all parts for all cars and trucks. A basic stock of fast-moving items may be carried and other parts ordered as needed. For this reason, it is important to know the types of parts available from different suppliers.

- Parts Distribution Centres – New vehicle dealerships purchase nearly all of their parts from manufacturers' distribution centres. Only dealers can buy parts from these centres. They buy at a special price and the selection of parts includes nearly everything on the vehicle. Distribution centres are found in large major cities. If you live in a smaller centre, it may take several days before delivery.

- Parts Departments of Dealerships – These specialize in selling and/or servicing one or more makes of vehicles and they supply other shops with automotive parts for similar vehicles.

  Dealerships sell parts at two different prices, depending on who is buying the part.
  - Retail or list price is for the public. It is the higher price.
  - Dealer price is for recognized businesses in the automotive industry, identified with a written purchase order. Dealer price is generally 15% to 20% lower than retail or list price.

- Jobbers – These are independently owned parts stores that specialize in selling one vehicle manufacturer's products (e.g., ignition parts and other fast-moving items). Jobbers are closely related to one manufacturer and display the vehicle manufacturer's emblem. This emblem allows parts buyers to identify this type of outlet. A majority of a jobber's business is from automotive shops in the area, but most will sell parts to the public at list price.

- Retail Auto Parts Suppliers – Most of these stores carry a wide variety of similar brand name products for the local automotive consumer. Some stores specialize in one product such as radios and stereos and sell at list price to the public and a reduced price to local automotive shops.

- Department Stores – A professional automotive shop will seldom purchase parts from department stores because these stores:
  - offer only a very limited supply of parts in stock
  - charge list or retail prices.

JOB SHEET 4
IDENTIFYING LOCAL AUTOMOTIVE SUPPLIERS

EQUIPMENT, TOOLS AND SUPPLIES

- Advertising directory (e.g., telephone, business)

PROCEDURE

1. Use the Yellow Pages or other local directories to identify five automotive parts suppliers in or around the community.

2. In each case, identify the type of supplier. (Watch for manufacturers' logos, the term "wholesale" and the type of products offered, to give you a clue as to each type of parts outlet.)

3. Complete the chart below.

Business Name	Address	Type of Supplier

4. Share your chart with your classmates.

5. Using the following chart as a guide, evaluate your performance.

	Excellent 4	Very Good 3	Good 2	Not Acceptable 1
Five suppliers were identified.				
Each supplier was an automotive parts supplier.				
Each supplier was classified properly.				
The chart was legible.				

DISCUSSION TOPICS

1. How do many large automotive suppliers maintain contact with their customers?

2. What is the process used for a service station to order a part by telephone and have it delivered?

SHOP REFERENCES

Shop references are resources that show details of parts and procedures. References or service manuals vary. They include books, magazines, microfiche and computer disks. Most shops use two types of service manuals:

- Manufacturer's Shop Manuals – These books are produced by vehicle manufacturers and relate to one year's model. The instructions are very specific and refer to special tools for each repair operation. Dealership shops use these manuals when servicing vehicles.

- General Shop Manuals – These books deal with the repair and service of more than one make or type of vehicle. They also tend to cover several years' production of various vehicles. They contain good quality information and allow the amateur worker to do automotive work without the use of many special tools. They are popular reference books in smaller automotive shops.

STUDENT ACTIVITIES

1. Locate and identify three service manuals in your lab or workplace, their year, and the type of vehicle(s) each is referenced to.

Title of Manual	Year	Vehicles Referenced
• _____	_____	_____
• _____	_____	_____
• _____	_____	_____

2. Visit each of the following automotive repair shops and identify the types of reference materials used by each.

   - Dealership _____
     _____
   - Local Service Station _____
     _____

3. Discuss each of the following topics and record the major points from each discussion:

   a. Why are shop manuals important to automotive service workers?

   _____

   _____

   _____

   b. What are the advantages and disadvantages of computer-based references as opposed to shop manuals?

   _____

   _____

   _____

   c. If you wanted your vehicle serviced, which type of service outlet would you take it to? Why?

   _____

   _____

   _____

JOB SHEET 5
USING SHOP MANUALS

EQUIPMENT, TOOLS AND SUPPLIES

- Pen or pencil
- Suitable shop manuals

PROCEDURE

1. Use a shop manual to identify and record the following information.

   - The bore size of a 1988 Jeep with a 4.0 litre engine. _____.
   - The ignition timing for a 1986 Chevrolet truck (C20) with a 5.7 litre engine. _____.
   - The sparkplug gap for a 1990 Volkswagen Jetta car. _____.
   - How would you remove a water pump on a 1991 Plymouth Acclaim without air conditioning (A/C) or power steering (P/S)?

- Draw a simple diagram to show how the timing marks on the camshaft and crankshaft gears should be positioned to install a timing chain. Use a 1980 Mercury Cougar with a 5.0 litre 8 cylinder engine for your example.

2. Using the following chart as a guide, evaluate your performance.

	Excellent 4	Very Good 3	Good 2	Not Acceptable 1
All questions in the procedure were completed.				
The answers were accurate.				

EQUIPMENT CARE AND MAINTENANCE

Proper care, cleaning, lubrication and adjustment of shop equipment help to ensure that automotive service work is safe, accurate, efficient and pleasant.

Each item of equipment requires special maintenance.

STUDENT ACTIVITIES

1. Observe your teacher's or supervisor's demonstration of equipment care and maintenance.

2. Record the proper care and maintenance procedures for each of the items of equipment shown on the following chart:

	CARE AND MAINTENANCE CHART			
Equipment	Operation	When?	How?	With What?
Hoist	Grease			
	Check Operation			
	Clean			
Floor Jacks	Grease			
	Hydraulic Oil Level			
	Check Operation			
	Clean			

	CARE AND MAINTENANCE CHART			
Equipment	Operation	When?	How?	With What?
Jack Stands	Check Operation			
	Clean			
Pressure Washer	Lubricate			
	Check Operation			
	Clean			
Compressor	Oil Level			
	Lubricate			
	Water Drain			
	Belt Inspection			

JOB SHEET 6
MAINTAINING EQUIPMENT

PROCEDURE

Perform basic maintenance on each item of equipment listed below. Record the date and operations you performed.

Equipment	Operations Performed	Dates
Hoist		
Floor Jack		
Jack Stands		
Pressure Washer		
Compressor		

Caution: Follow all related safety rules whenever performing these maintenance tasks.

SCHEDULING MAINTENANCE DUTIES

In a well-run business, each worker knows what to do and when to do it. A daily, weekly or monthly work schedule is sometimes posted on an automotive shop's staff notice board to inform each employee of their general and specific duties in the work area.

General duties include ensuring that:

- equipment is properly maintained and stored
- damaged items are reported, repaired and/or replaced
- the shop is kept as clean as possible
- safe practices are followed.

Specific duties of each employee may include:

- maintaining a clean, safe work area
- providing and wearing suitable coveralls
- taking turns in performing general shop maintenance duties (e.g., sweeping the floors, checking washrooms).

STUDENT ACTIVITIES

1. Brainstorm and list the maintenance jobs necessary at each of the following times in an automotive shop:

   - Daily tasks

     _____
     _____
     _____
     _____
     _____

   - Weekly tasks

     _____
     _____
     _____
     _____

- Tasks that are done only once a month or at longer intervals.

2. Discuss: "What are the advantages of having maintenance duties scheduled and posted?"

3. Visit a local automotive repair shop to answer the following questions:

   - Are shop maintenance schedules used to provide direction to workers?

   - When are shop maintenance duties done?

   - What shop maintenance duties are done by the workers?

TOOLS AND FASTENERS

HAND TOOLS

Hand tools of many types are used in automotive repair. Some of the uses for hand tools include:

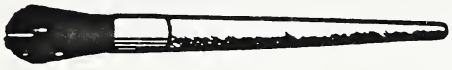
- turning
- striking
- holding
- cutting
- cleaning.

STUDENT ACTIVITIES

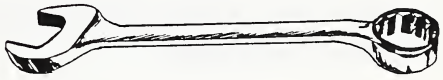
1. Write the name of each hand tool illustrated and describe its intended use.

Name: _____
Use: _____

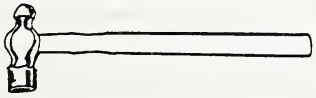
Name: _____
Use: _____



Name: _____
Use: _____



Name: _____
Use: _____



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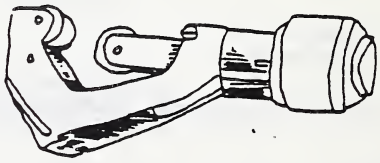


Name: _____ Name: _____

Use: _____ Use: _____

2. Visit four local automotive repair shops or tool dealers and discuss the following questions with a mechanic or salesperson:

   a. How much does a full set of mechanic's tools cost?

   COST OF A MECHANIC'S TOOL SET

Shop 1		
Shop 2		
Shop 3		
Shop 4		

Average cost for a full set of mechanic's tools would be? $

b. How much does a set of tools cost an entry-level employee such as a mechanic's helper?

COST OF A HELPER'S TOOL SET

No. 1		
No. 2		
No. 3		
No. 4		

Average cost of a tool set for an entry-level employee would be? $

c. What are the advantages and disadvantages of owning your own set of tools?

Advantages	Disadvantages

d. What are some of the important points for taking care of a set of hand tools?

MEASURING TOOLS

Measurement is important to the automotive service worker because vehicle parts must fit together correctly. Both metric and imperial measuring tools may be used to diagnose problems, determine wear, and check the fit of parts.

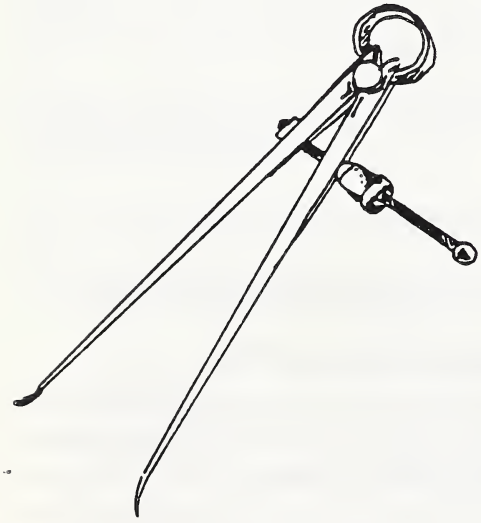
Two of the more commonly used measuring tools are:

- calipers
- micrometers.

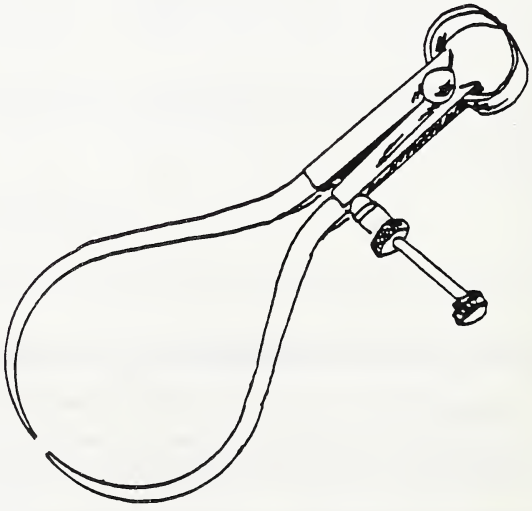
CALIPERS

One of the more commonly used measuring tools are calipers. Calipers are used to check an object's size quickly. They do not have a scale of their own so are not considered accurate. To obtain a measurement, the distance between the calipers' points may be measured with a ruler.

Note: Never use force or pressure on the measuring arms of calipers.



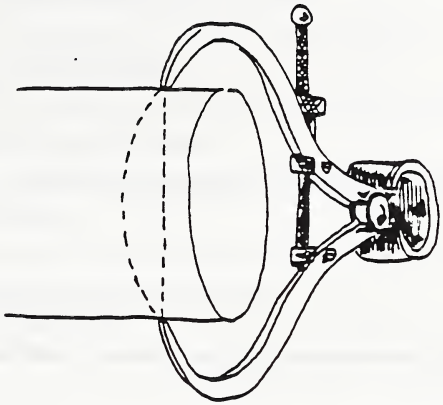
INSIDE CALIPERS



OUTSIDE CALIPERS

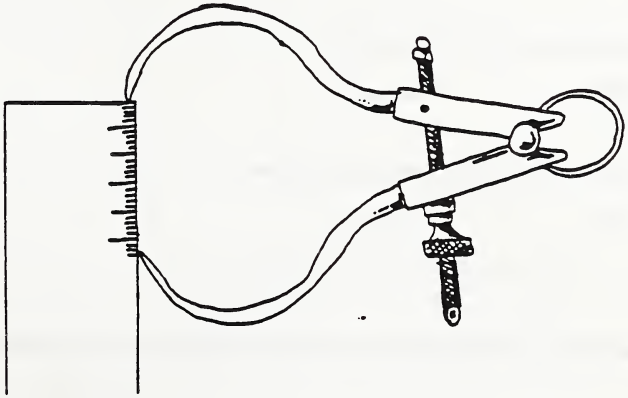
Using Calipers

1. Adjust the calipers so they lightly drag on the surface of the object to be measured.



2. Place the points of the calipers alongside a ruler.

3. Record the measurement of the object.



JOB SHEET 7
MEASURING WITH CALIPERS

EQUIPMENT, TOOLS AND SUPPLIES

- Inside calipers
- Outside calipers
- Metric ruler
- Imperial ruler
- Sample objects (flat washer, stud, exhaust pipe, wheel cylinder bore)

PROCEDURE

1. Use the calipers and rulers to determine the size of each object in both metric and imperial scales.

2. Record your readings below.

- Outside diameter of the flat washer
  _____ mm _____ in.

- Length of the stud
  _____ mm _____ in.

- Inside diameter of the exhaust pipe
  _____ mm _____ in.

- Inside diameter of the wheel cylinder bore
  _____ mm _____ in.

3. Clean and return the equipment, tools and sample objects to their proper storage areas.

4. Using the following chart as a guide, evaluate your performance.

	Excellent 4	Very Good 3	Good 2	Not Acceptable 1
The proper equipment, tools and samples were selected.				
The measuring tools were handled properly.				
Excessive force was avoided during measuring.				
The measurements were accurate.				
The equipment, tools and samples were cleaned and returned to their proper storage areas.				

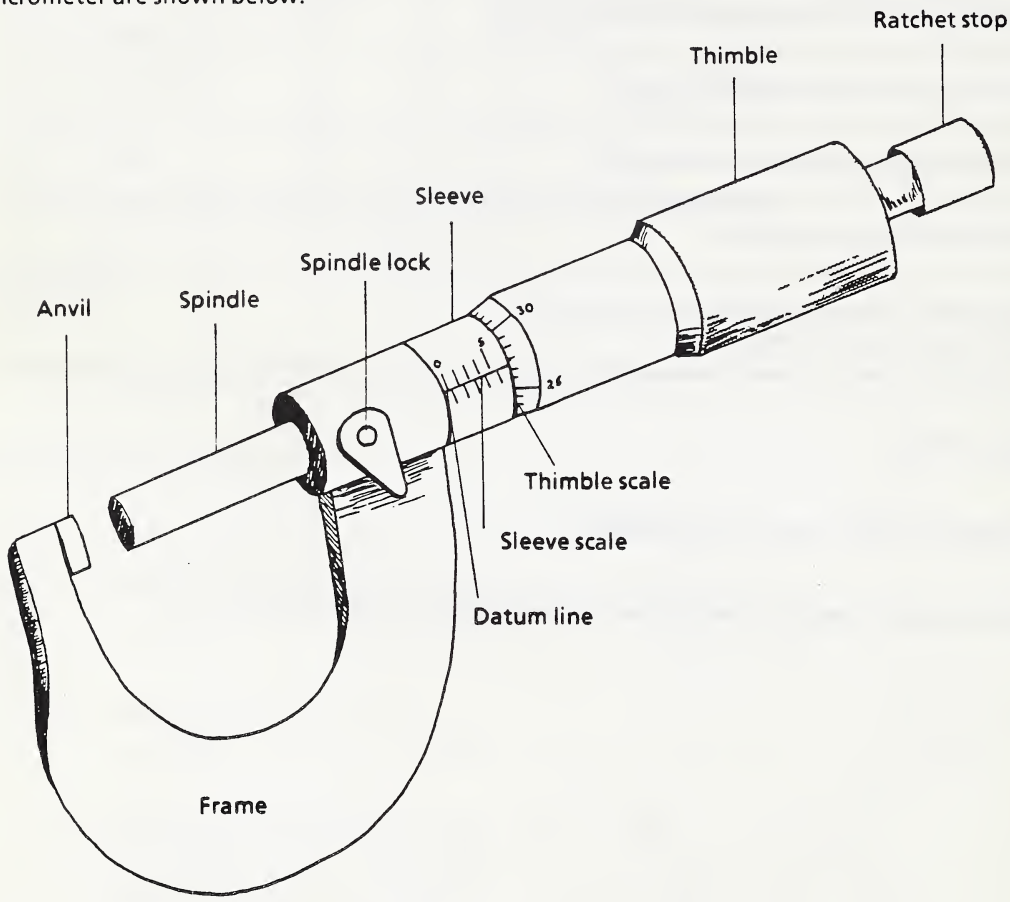
DISCUSSION TOPICS

1. What types of repairs require measurement?

2. What specialized measuring tools are used in the automotive repair industry?

MICROMETERS

The micrometer is an accurate measuring tool used to measure dimensions. The major parts of a basic micrometer are shown below.



Anvil – touches the object to be measured.

Spindle – moves in and out to touch the object to be measured.

Sleeve – exposed as thimble is unscrewed.

Thimble – moves the spindle in and out when turned.

Ratchet stop – prevents over-tightening, and is used to turn the thimble.

Thimble scale – gives final precise reading (.01 mm or .001").

Sleeve scale – gives initial reading (.50 mm or .025").

Datum line – point at which thimble reading is taken.

Spindle lock – locks micrometer.

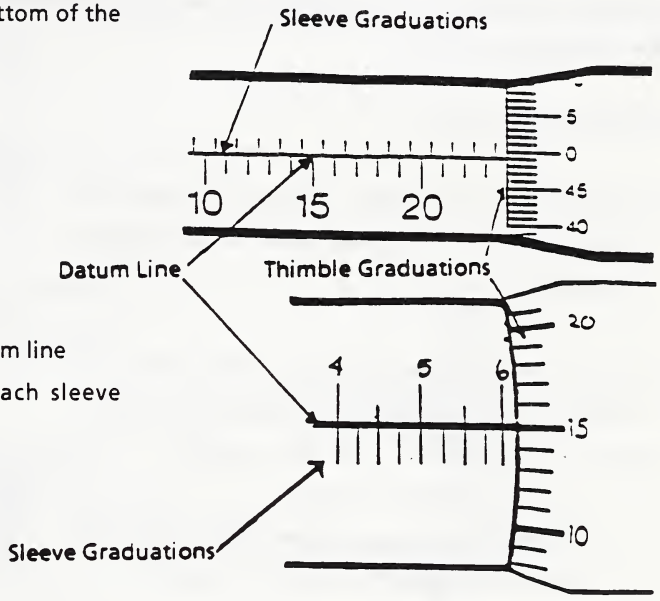
Frame – holds anvil and spindle sections together.

Metric and Imperial Micrometers

Automotive employees must be able to tell the difference between metric and imperial micrometers.

Metric micrometers have:

- graduation marks on the top and bottom of the datum line
- sleeve scales marked up to 25
- 50 thimble graduations.



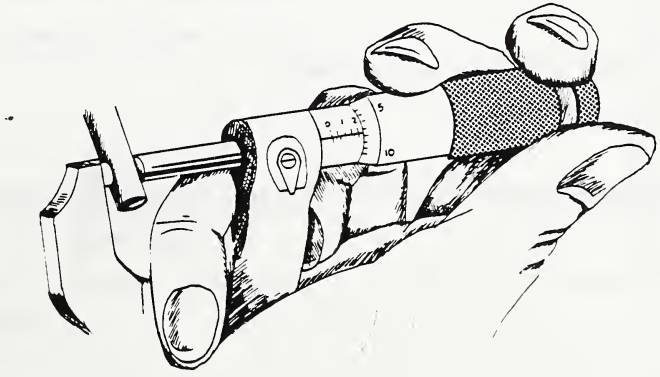
Imperial micrometers have:

- graduation lines only below the datum line
- four small graduations between each sleeve graduation
- the last sleeve scale number is "1"
- 25 thimble graduations.

Using a Micrometer

Micrometers are precision tools and must be handled carefully to ensure accuracy and prevent damage to the tool.

- Hold the micrometer correctly in one hand.
- Tighten the micrometer with thumb and index finger turning only the ratchet stop.



- Do not use a micrometer as a hammer.
- Do not over-tighten a micrometer. Use the ratchet stop for consistency and accuracy.
- Keep the micrometer clean, lightly oiled and in the case provided.
- Be careful not to drop a micrometer. Its accuracy in measurement may be damaged.

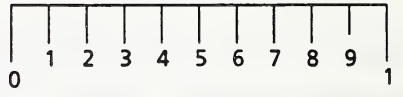
Reading the Imperial Micrometer

The imperial micrometer can be used to measure to 1/1000th of an inch (.001"). The thickness of this page, for example is .002".

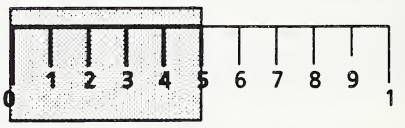
To build the sleeve scale:

- First draw a line 1" long. (These drawings are larger than normal to make it easy for you to read the scales.)

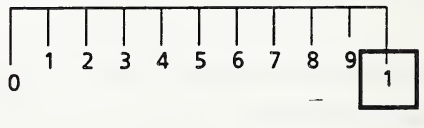
- Next divide the scale into ten equal parts and number the graduations. Each graduation is equal to 1" ÷ 10 = 1/10" = .1" = .10" = .100".



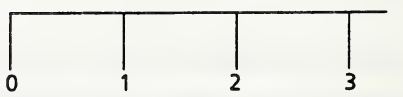
A measurement up to the end of the 5th graduation is equal to .100" × 5 = .500".



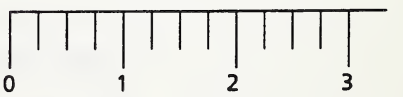
The large number 1 at the far end of the scale is used instead of a 10 to remind you that it represents 1" = 10/10.



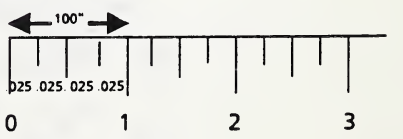
By expanding our drawing we can see the rest of the graduations easily.



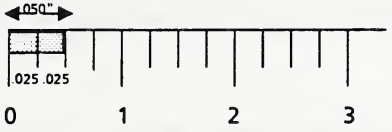
- Each large graduation is divided into four smaller divisions.



Each of the smaller divisions is equal to .100 ÷ 4 = .025"



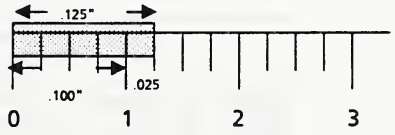
A measurement that covers two full smaller sleeve graduations is equal to .025" × 2 = .050".



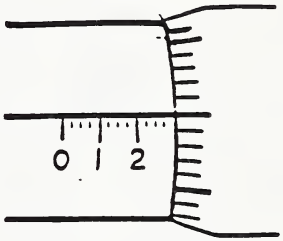
To calculate reading "×" add .100"

+ .025"

.125"

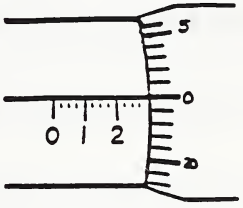


To calculate the sleeve scale reading, count the number of FULL sleeve scale graduations uncovered by the edge of the thimble.

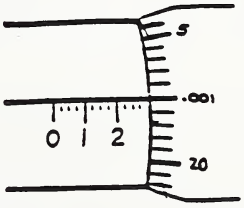


The sleeve scale permits objects to be measured to an accuracy of .025". The thimble scale allows .001" accuracy.

As the thimble is turned, observe that each complete turn of the thimble is equal to one full, small graduation on the sleeve scale.



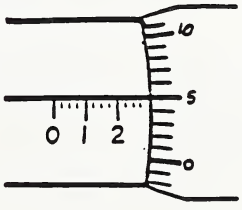
Each of the 25 thimble graduations are equal to: .025" ÷ 25 = .001". (Small sleeve graduations ÷ number of thimble graduations = thimble graduation value.)



The datum line points to the thimble scale reading.

.001" × 5 = .005"

(Thimble scale value × number of thimble graduations = measurement.)

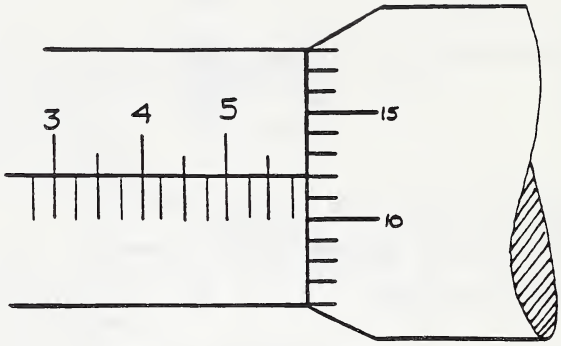


The micrometer sleeve and thimble scales shown read:

1. Large graduations on the sleeve scale.
   $5 \times .100" = .500"$

2. Full small sleeve graduations visible after the #5.
   $3 \times .025" = .075"$

3. Thimble scale graduations.
   $12 \times .001" = .012"$



	.500"
"ADD"	.075"
	.012"
	.587"

Remember:

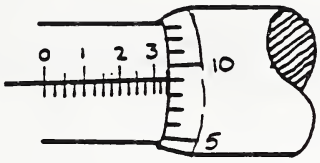
1. Always write down your calculations.

2. Start with the large value graduations.

3. Add the abbreviation (in.) or the symbol (") after each micrometer reading.

STUDENT ACTIVITIES

Read the measurements shown on diagrams B, C, D and E. Be sure to show your work and include units of measurement.



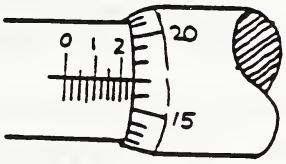
A Example:

3 × .100 = .300

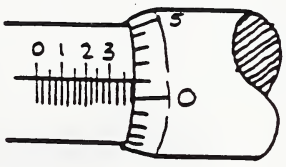
2 × .025 = .050

9 × .001 = .009

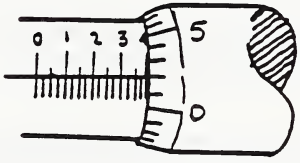
.359"



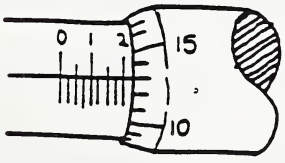
B



C



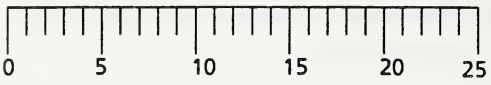
D



E

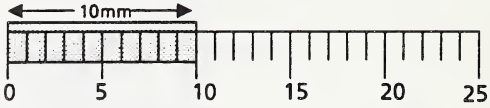
Reading a Metric Micrometer

A metric micrometer sleeve scale is 25 mm long and has 25 divisions. It is marked every 5 mm.

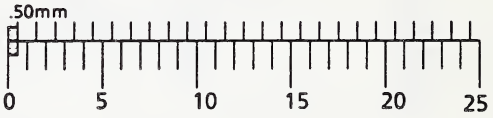


Each large graduation is equal to 25 mm ÷ 25 = 1 mm or 1.0 mm or 1.00 mm.

The measurement indicated to the right is equal to 10 × 1.00 = 10.00 mm.



On the top of the datum line there are marks halfway between the large graduations. Each of these small marks is equal to 1.00 ÷ 2 = .50 mm.

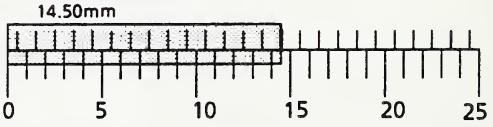


The measurement to the right is equal to

14 × 1.00 = 14.00

1 × .50 = .50

14.50 mm



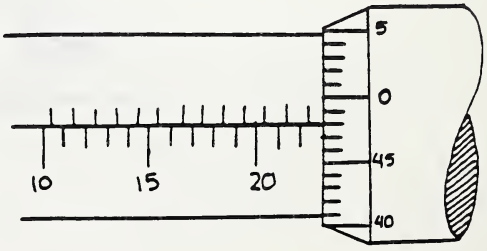
Sleeve scale readings are determined by counting only the full graduations (large and small) showing past the edge of the thimble. Partial sleeve scale graduations are shown in the thimble readings.

Turn the thimble of the metric micrometer and observe that for every complete thimble turn, the edge of the thimble travels .50 mm.

If there are 50 graduations, each one is equal to .50 ÷ 50 = .01 mm.
(Value of one thimble turn ÷ number of thimble graduations = thimble graduation value.)

The thimble reading on the metric micrometer scale (a) shown is:
48 × .01 = .48 mm.

(a)



The metric micrometer reading (b) is:

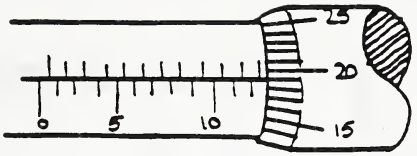
$12 \times 1.00 = 12.00$

$1 \times .50 = .50$

$19 \times .01 = .19$

12.69 mm

(b)



Remember:

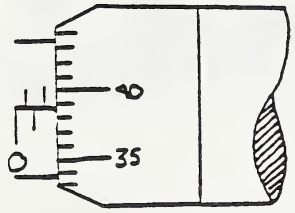
1. Always write down your calculations.

2. Calculate by starting with the largest graduations first.

3. Add the abbreviation "mm" after each metric micrometer reading.

STUDENT ACTIVITIES

Read the measurements shown on diagrams B, C, D and E. Be sure to include your work and units of measurement.



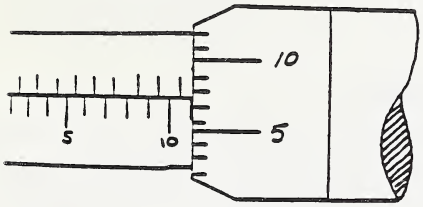
A. Example:

$1 \times 1.00 = 1.00$

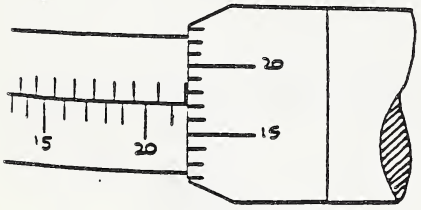
$1 \times .50 = .50$

$39 \times .01 = .39$

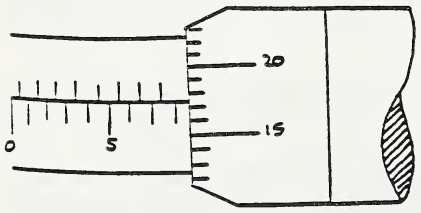
1.89 mm



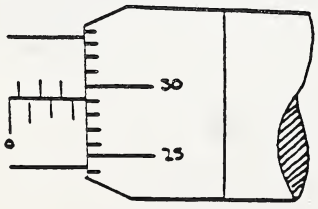
B.



C.



D.



E.

JOB SHEET 8
MEASURING WITH MICROMETERS

EQUIPMENT, TOOLS AND SUPPLIES

- Imperial micrometer
- Metric micrometer
- Sample objects (piston pin, lifter, washer, ball bearing, valve stem)

PROCEDURE

1. Carefully determine the measurements on the following objects. Readings are to be taken and recorded using both a metric and imperial micrometer for each sample object.

- Piston pin diameter
  _____mm _____in.
- Lifter diameter
  _____mm _____in.
- Washer thickness
  _____mm _____in.
- Ball bearing diameter
  _____mm _____in.
- Valve stem diameter
  _____mm _____in.

2. Return the equipment, tools and sample objects to their proper storage areas.

3. Using the following chart as a guide, evaluate your performance.

	Excellent 4	Very Good 3	Good 2	Not Acceptable 1
The proper equipment, tools and samples were selected.				
The measurements were accurate.				
The equipment, tools and samples were cleaned and returned to their proper storage areas.				

FASTENERS

Fasteners are items used to hold two or more parts together. Every vehicle uses thousands of fasteners and shop employees must know the name and proper use of each type of fastener.

STUDENT ACTIVITIES

1. As a class, inspect a vehicle and identify the common types of fasteners shown below.

2. Name each fastener illustrated, and give an example of its use.

Name: _____

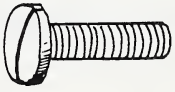
Use: _____

Name: _____

Use: _____

Name: _____

Use: _____



Name: _____

Use: _____

Name: _____

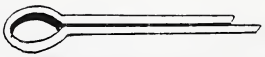
Use: _____

Name: _____

Use: _____

Name: _____

Use: _____

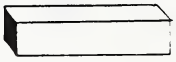


Name: _____

Use: _____

Name: _____

Use: _____



Name: _____

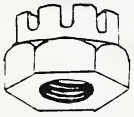
Use: _____

Name: _____

Use: _____

Name: _____

Use: _____



Name: _____

Use: _____

Name: _____

Use: _____

CLEANING VEHICLES

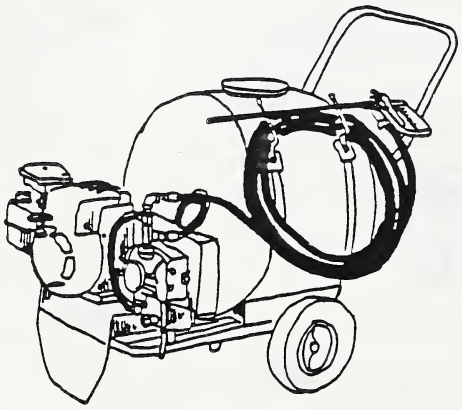
Detailing is the term used to describe the cleaning, polishing and reconditioning of vehicles. A clean vehicle looks better to its owner or may improve its saleability on a used vehicle lot.

Detailing removes road film, slows down rusting and prevents other damage to the surface of the vehicle.

The following equipment is used to detail vehicles:

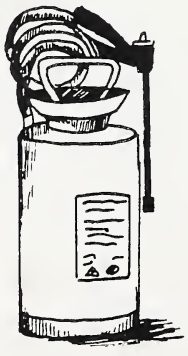
Pressure Washers

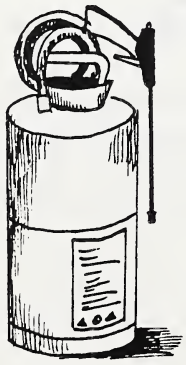
These machines mix soap and water to produce a high pressure spray to wash the exterior of a vehicle. **Never point the spray gun wand at another person; the high pressure water and chemicals can cause serious injury.**



Booster Sprayers

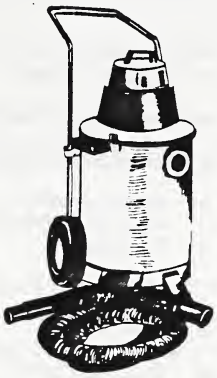
This equipment sprays liquid chemicals on the surface of the area to be cleaned. Always check the chemical container labels to ensure that proper safety precautions are taken.





Vacuum Cleaners

High powered vacuum cleaners are used to clean a vehicle's upholstery, rugs and trunk surfaces.



Power Polishers

These units spin soft polishing pads to buff wax applied to the vehicle's surface. Although polishers spin fairly slowly, avoid polishing loose trim.

Other detailing tools and supplies include:

Tools	Supplies
sponges	car wash soap
rags	degreasers
hoses	waxes/glazes
brushes	polishing compounds
steel wool	vinyl cleaners
squeegees	vinyl dressings
chamois	chrome polishes
pails	tire cleaners

JOB SHEET 9
DETAILING A VEHICLE

EQUIPMENT, TOOLS AND SUPPLIES

REQUIRED

- Pressure washer
- Car wash soap
- Car wash mitt or brush
- Vacuum cleaner
- Vinyl cleaner
- Safety glasses
- Protective clothing
- Window cleaner
- Paper towels
- Squeegee

OPTIONAL

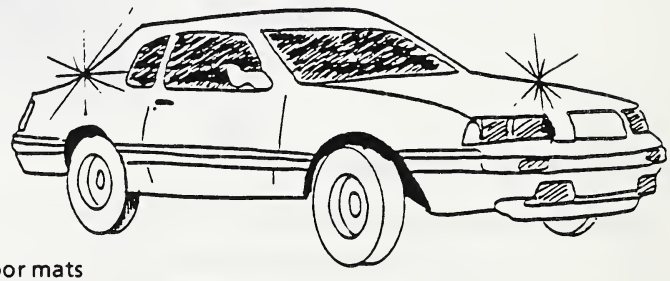
- Power polisher
- Wax
- Tire cleaner
- Rug shampoo

PROCEDURE

1. **Put on the safety glasses and protective clothing.**

2. Park the vehicle in the wash bay, then remove the mats and roll up all of the windows.

3. Clean the interior:



   a. wipe off all vinyl surfaces
   b. empty and clean out ashtray
   c. clean windows
   d. vacuum or scrub the removed floor mats
   e. vacuum upholstery
   f. vacuum rugs
   g. replace floor mats.

   (Shampoo the interior if supplies and time are available.)

4. Clean the trunk with the vacuum cleaner.

5. Clean the exterior:

   a. spray tire cleaner or strong soap solution on side walls and scrub with brush

   b. wash the vehicle exterior with pressure washer and wash mitt or brush
   Caution: Do not point the high pressure spray at anyone's skin or eyes.

   c. rinse the vehicle thoroughly with water

   d. dry the vehicle with a chamois leather.
   (Complete waxing and polishing if supplies and time are available.)

6. Return the vehicle to the parking area.

7. Clean up the wash bay and squeegee any excess water into the drain.

8. Clean and return all equipment, tools and supplies to their proper storage areas.

9. Using the following chart as a guide, evaluate your performance.

	Excellent 4	Very Good 3	Good 2	Not Acceptable 1
The proper equipment, tools and supplies were selected.				
All steps in the procedure were completed.				
The exterior was clean.				
The interior was clean.				
The windows were smudge-free.				
The vehicle was parked properly.				
All related safety precautions were demonstrated.				
The equipment, tools and supplies were cleaned and returned to their proper storage areas.				
The work area was cleaned up.				

DISCUSSION TOPICS

1. What other techniques can be used to clean a vehicle?

2. What is the cost of professional vehicle detailing?

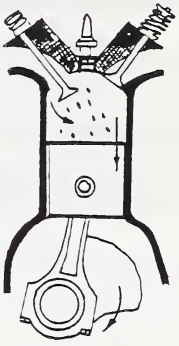
AUTOMOTIVE ENGINES

The engine found in most modern vehicles uses a basic design that has not changed for many years. The design of an automotive engine consists of pistons sliding up and down inside cylinders. Valves are used to control the inlet and exhaust of gases.

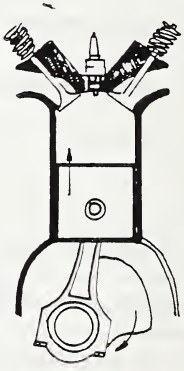
Each movement of the piston, top-to-bottom or bottom-to-top, is called a **STROKE.** It takes four strokes to complete the burning of engine fuel. This sequence of events is called the **FOUR-STROKE CYCLE.**

THE FOUR-STROKE CYCLE

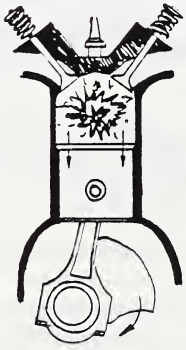
The four strokes of a four-stroke cycle engine are:



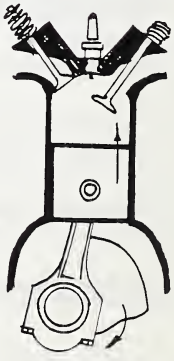
1. Intake Stroke
   - piston moves down
   - intake valve opens
   - exhaust valve closes
   - air/fuel mixture is drawn into engine.



2. Compression Stroke
   - piston moves up
   - both valves are closed
   - air/fuel mixture is heated.



3. Power Stroke
   - piston moves down
   - both valves are closed
   - fuel is burned and a power surge is produced.



4. Exhaust Stroke
   - piston moves up
   - intake valve is closed
   - exhaust valve opens
   - exhaust gases forced out of cylinder.

The four-stroke cycle is the same for gasoline, propane, natural gas and alcohol-fueled engines. In addition, the mechanical movements are the same for diesel engines.

STUDENT ACTIVITIES

1. Review the construction and operation of the four-stroke cycle engine.

2. Describe the four-stroke cycle by completing the following chart:

FOUR-STROKE CYCLE CHART

No.	Stroke Name	Piston Direction	Intake Valve Position	Exhaust Valve Position	Purpose
1					
2					
3					
4					

2. Use class, library and workplace resources to help you answer the following questions:

   a. What are the major differences between a two-stroke and a four-stroke engine?

   _____

   _____

   b. What purpose does fuel (e.g., gasoline, propane, natural gas) serve when put into a four-stroke engine?

   _____

   _____

3. Draw a flow chart to show the sequence of activities that occur in a four-stroke engine.

JOB SHEET 10
IDENTIFYING ENGINE COMPONENTS

EQUIPMENT, TOOLS AND SUPPLIES

- Engine components (50) assorted, numbered
- Automotive references
- Pen or pencil

PROCEDURE

1. Examine each of the engine components.

2. On the following chart, write the proper name for each component.

   Note: Each name must be written opposite the matching number of the component.

Number	Component Name
e.g.,	oil control ring
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	

Number	Component Name
14	
15	
16	
17	
18	
19	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
30	
31	
32	
33	
34	
35	
36	
37	

Number	Component Name
38	
39	
40	
41	
42	
43	
44	
45	
46	
47	
48	
49	
50	

3. Submit your workbook to the teacher/supervisor for marking.

   Note: The teacher/supervisor may prefer to provide a key for self-marking.

4. Find the proper names for the items that you misnamed.

   a. How many did you correctly identify? _____

   b. What percentage of the total did you correctly identify? _____%

6. Return the components and automotive references to their proper storage areas.

ENGINE SUPPORT SYSTEMS

An engine is a collection of mechanical parts. In order to operate properly, these parts require the help of a number of engine support systems.

Fuel System – mixes air and fuel in the right proportions for all operating conditions.

Cooling System – removes excess heat, promotes fast warm-up and keeps engine at proper operating temperature.

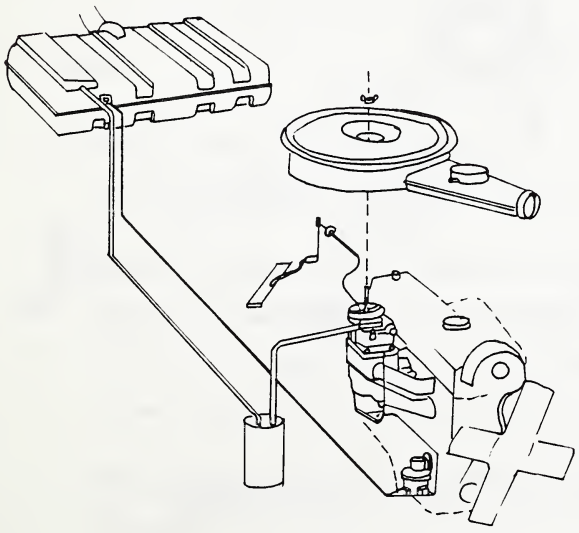
Lubrication System – reduces friction, cleans inside of engine and seals parts such as piston rings.

Ignition System – provides a hot spark at the right time in the cylinder to ignite the fuel.

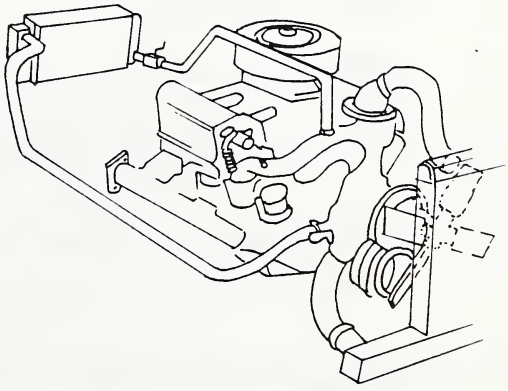
Air Intake or Induction System – cleans and directs air into the engine. Prevents flames from escaping if engine backfires.

Exhaust System – removes exhaust from engine area and quiets the sound of the hot gases.

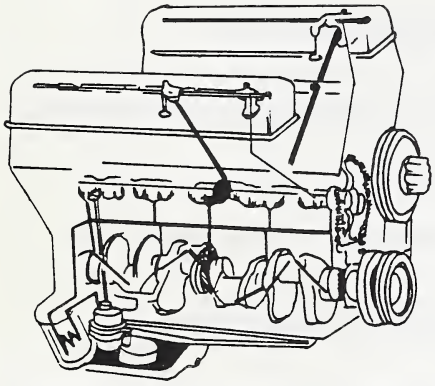
The following diagrams show the major parts of each of these support systems:



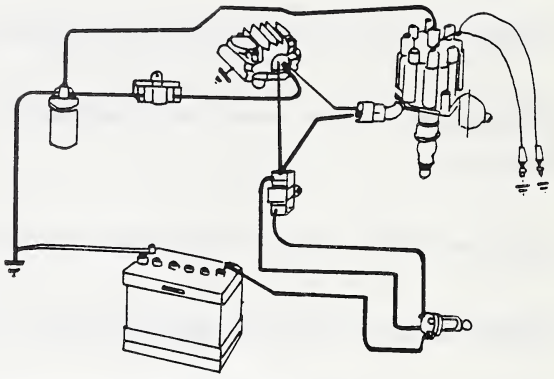
Fuel System



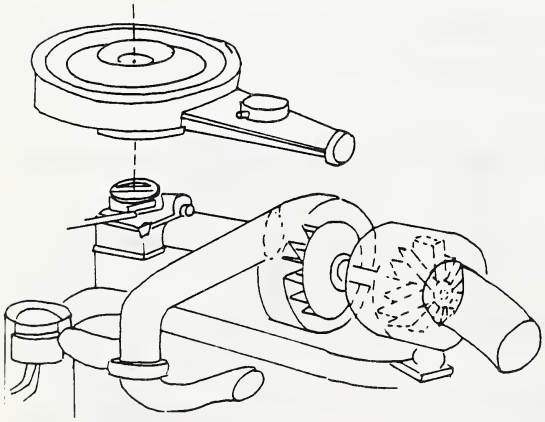
Cooling System



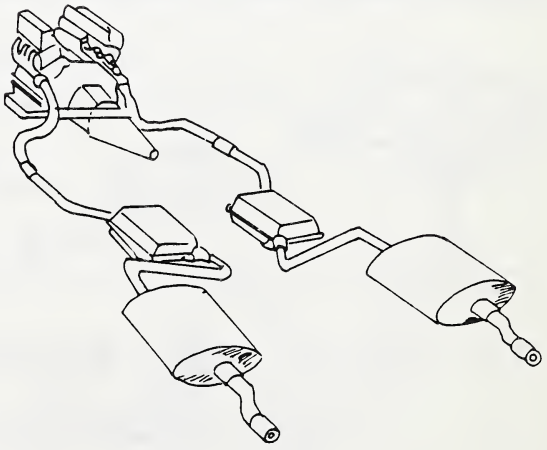
Lubrication System



Ignition System



Air Intake or Induction System



Exhaust System

STUDENT ACTIVITIES

1. In your own words, describe the purpose of each of the following engine support systems.

   Fuel System _____

   _____

   Cooling System _____

   _____

   Lubrication System _____

   _____

   Ignition System _____

   _____

   Air Induction System _____

   _____

   Exhaust System _____

   _____

2. Discuss:

   a. What is meant by the term "system"?

   _____

   b. The term "system" is used to describe functions of the human body. What are five systems that help to keep the human body operating?

   _____

   _____

   c. What happens when one system fails to operate properly? How could other systems be affected?

   _____

   _____

JOB SHEET 11
IDENTIFYING ENGINE SUPPORT SYSTEM COMPONENTS

EQUIPMENT, TOOLS AND SUPPLIES

- Vehicle (safely supported on jack stands)
- Creeper
- Shop reference books
- Trouble light
- Pen or pencil

PROCEDURE

Caution: The engine must be cool and the keys must be removed from the ignition switch prior to starting this task.

1. Locate and identify each of the components listed on the following page for each engine support system.

2. As each component is located check it off on the appropriate charts.
   Note: Some components are duplicated, such as carburetors or fuel injectors.

3. Have your teacher or supervisor help you if any of the components cannot be located on the vehicle.

4. Clean and return all equipment, tools and supplies to their proper storage areas.

5. Clean up the work area.

6. Using the following chart as a guide, evaluate your performance.

	Excellent 4	Very Good 3	Good 2	Not Acceptable 1
The proper equipment, tools and supplies were selected.				
All steps in the procedure were completed.				
All required components were identified.				
The components were identified correctly.				
All related safety precautions were demonstrated.				
The equipment, tools and supplies were cleaned and returned to their proper storage areas.				
The work area was cleaned up.				

FUEL SYSTEM

fuel tank	
fuel lines	
fuel pump	
fuel filter	
carburetor	
fuel injectors	
accelerator linkage	

COOLING SYSTEM

radiator	
radiator hoses	
water pump	
thermostat housing	
heater hoses	
heater core	
overflow tank	
radiator cap	

LUBRICATION SYSTEM

oil pan	
valve covers	
oil filler plug	
oil dipstick	
oil filter	

IGNITION SYSTEM

battery	
ignition switch	
distributor	
spark plug wires	
spark plugs	

AIR INDUCTION SYSTEM

air filter housing	
air filter	
intake manifold	

EXHAUST SYSTEM

exhaust manifold	
exhaust pipe	
catalytic converter	
muffler	
tailpipe	

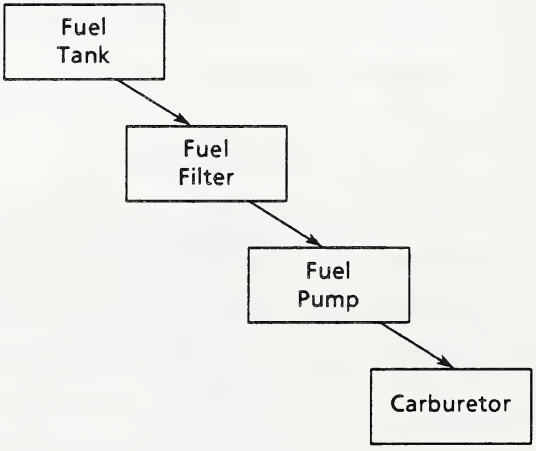
AUTOMOTIVE FUEL SYSTEMS

The fuel system performs two basic jobs:

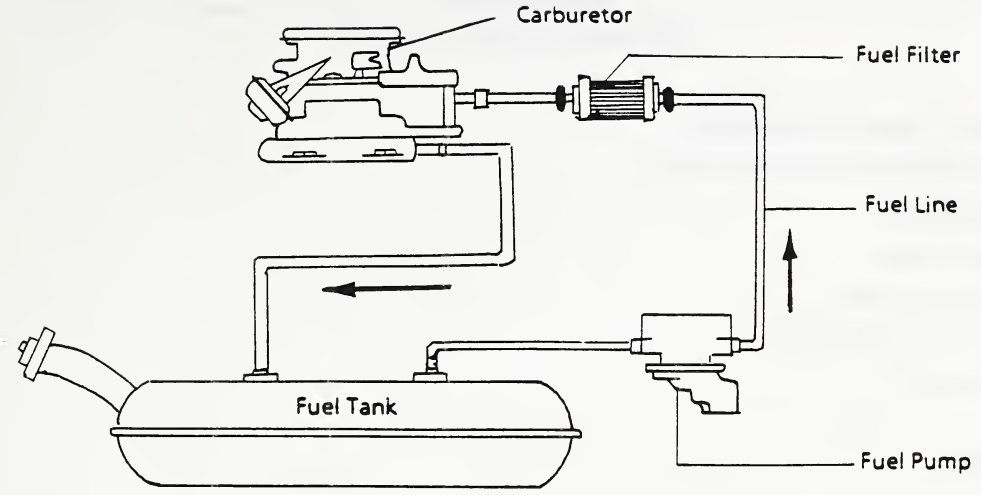
- stores fuel
- mixes air and fuel in right proportions for current operating conditions.

SYSTEM COMPONENTS

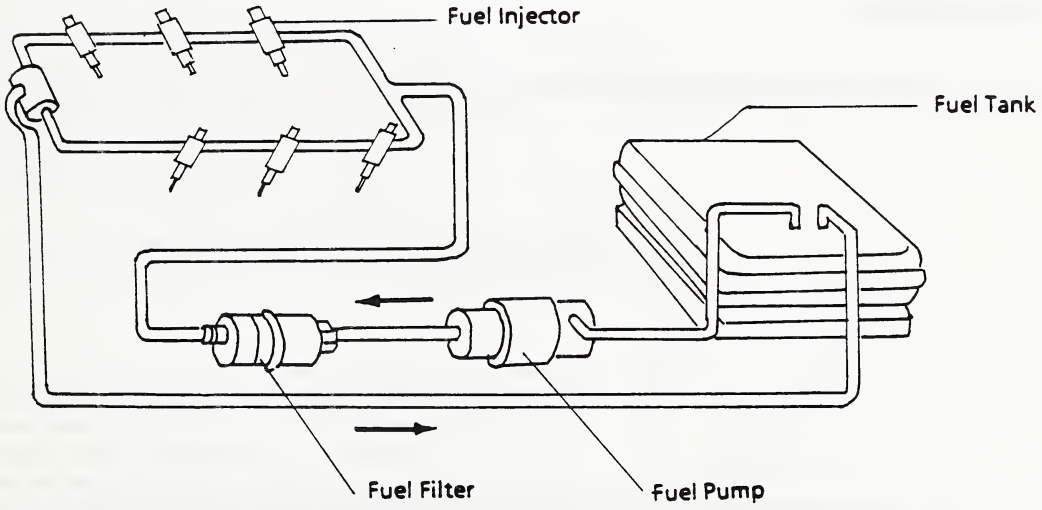
- Fuel tank – stores the fuel and allows heavy contaminants (e.g., dirt, water) to settle out of the fuel.
- Fuel filter – strains out contaminants that could hurt other system components.
- Fuel pump – moves gasoline from the tank to the mixing unit.
- Lines and hoses – carries gasoline from one component to another.
- Carburetor – this component mixes fuel with the air according to current demands. In modern vehicles this unit is frequently replaced with a fuel injector.



Note: Steel fuel lines and synthetic rubber fuel hoses are used to carry the fuel between components.



CARBURETED SYSTEMS



INJECTED SYSTEMS

Although the basic storage and supply components are the same for all fuel systems they may be arranged or located in a different fashion.

JOB SHEET 12
TRACING THE FUEL SYSTEM

EQUIPMENT, TOOLS AND SUPPLIES

- Vehicle safely supported on a hoist
- Trouble light
- Safety glasses
- Protective clothing
- Automotive references
- Pen or pencil

PROCEDURE

1. **Put on the safety glasses and protective clothing.**

2. Locate the fuel system components on a shop vehicle. Trace the fuel flow from the tank to the fuel mixing device.

3. List the names of the parts in order of fuel flow.

   a.
   b.
   c.
   d.
   e.
   f.
   g.

4. Show your teacher/supervisor where each component is located and the fuel flow path.

5. Draw a diagram to show the components and the direction of fuel flow in the vehicle examined.

6. Clean and return all equipment, tools and supplies to their proper storage areas.

7. Clean up the work area.

8. Using the following chart as a guide, evaluate your performance.

	Excellent 4	Very Good 3	Good 2	Not Acceptable 1
The proper equipment, tools and supplies were selected.				
All steps in the procedure were completed.				
All fuel system components were identified.				
Direction of flow was correct.				
The diagram was legible and accurate.				
All related safety precautions were demonstrated.				
The equipment, tools and supplies were cleaned and returned to their proper storage areas.				
The work area was cleaned up.				

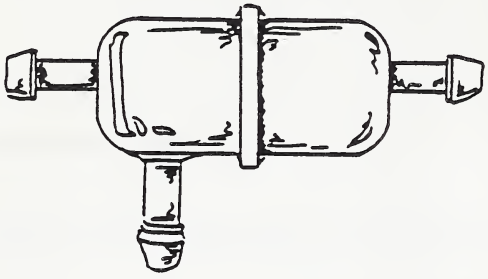
FUEL FILTERS

Fuel filters are used to remove dirt, dust, water, rust or other solid particles from fuel flow.

There are three main types of fuel filters:

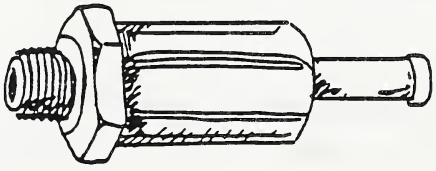
In-line fuel filters

These filters are installed somewhere in the fuel lines by the use of short rubber hoses and clamps. They are usually after-market items installed by people who want extra protection against dirty fuel.



Screw on fuel filters

These filters screw directly into the carburetor and provide an attachment for the fuel line.



In-carburetor fuel filters

These filters are located inside the carburetor behind the fitting where the fuel line installs.

Fuel filters should be changed:

- as part of regular maintenance (e.g., once a year)
- whenever a carburetor overhaul is performed
- whenever dirty fuel plugs the fuel filter.

JOB SHEET 13
LOCATING FUEL FILTERS

EQUIPMENT, TOOLS AND SUPPLIES

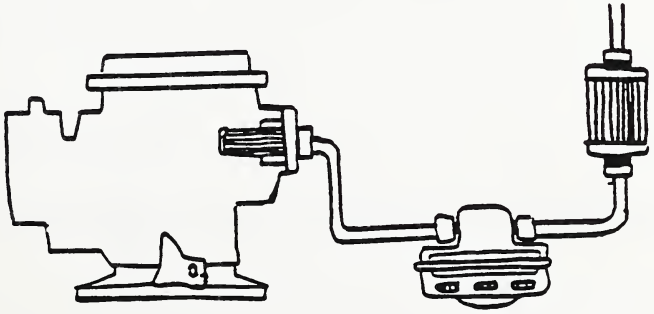
- Vehicles (2) safely supported on jack stands
- Trouble light
- Safety glasses
- Protective clothing
- Creeper
- Pen or pencil

PROCEDURE

1. **Put on the safety glasses and protective clothing.**

2. Locate the fuel filters on two different makes of vehicles and, with the aid of diagrams, record the information. Remember that many vehicles have more than one fuel filter.

	Year	Make	Model
Example: Unit Description	1983	Chevrolet	Malibu



Unit 1	Year	Make	Model

Unit 2	Year	Make	Model

3. Clean and return all equipment, tools and supplies to their proper storage areas.

4. Clean up the work area.

5. Using the following chart as a guide, evaluate your performance.

	Excellent 4	Very Good 3	Good 2	Not Acceptable 1
The proper equipment, tools and supplies were selected.				
All steps in the procedure were completed.				
All fuel filters were identified.				
The diagrams were correctly labelled.				
The diagrams were accurate and legible.				
All related safety precautions were demonstrated.				
The equipment, tools and supplies were cleaned and returned to their proper storage areas.				
The work area was cleaned up.				

DISCUSSION TOPICS

1. Why would multiple filters be used?

2. Would the addition of an extra in-line filter change the service life of the original filters?

JOB SHEET 14
CHANGING AN IN-LINE FUEL FILTER

EQUIPMENT, TOOLS AND SUPPLIES

- Vehicle
- Screwdrivers (if screw clamps to be used)
- Pliers (if spring clamps are to be used)
- Rags
- Safety glasses
- Protective clothing

PROCEDURE

Caution: This task must be performed outside or with an approved exhaust gases pickup hose connected to the tailpipe. All ignition sources must be eliminated from the immediate work area.

1. **Put on the safety glasses and protective clothing.**

2. Prepare the new filter assembly by installing hoses on the filter. Tighten both inner clamps in place. Loosely slide both outer clamps up against the inner clamps.

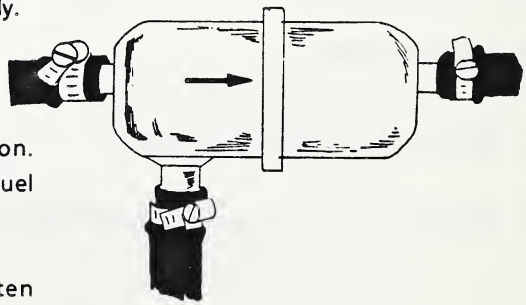
3. Locate the old filter.

4. Position a rag under the filter.

5. Loosen both outer clamps on the old filter assembly.

6. Twist and pull off the old filter assembly.

7. Install the new filter assembly in correct direction. Position the arrow in the direction in which the fuel flows toward the carburetor.



8. Slide the outer clamps in position and tighten enough to bulge rubber slightly up into the clamp slots.

9. **Wipe up any gas spills and dispose of the contaminated rag in fireproof container.**

10. With your teacher's/supervisor's permission, start up vehicle to check for leaks. Shut off the vehicle immediately if leaks are found. Retest after leaks are repaired.

11. Shut off the vehicle's ignition switch if no leaks are detected after three minutes of running.

12. Clean and return the equipment, tools and supplies to their proper storage areas.

13. Clean up the work area.

14. Using the following chart as a guide, evaluate your performance.

	Excellent 4	Very Good 3	Good 2	Not Acceptable 1
The proper equipment, tools and supplies were selected.				
All steps in the procedure were completed.				
The filter was installed in the proper direction.				
The filter connection did not leak.				
All related safety precautions were demonstrated.				
The equipment, tools and supplies were cleaned and returned to their proper storage areas.				
The work area was cleaned up.				

DISCUSSION TOPICS

1. What types of clamps are used on fuel filters?

2. Can all clamps be reused?

JOB SHEET 15
CHANGING A SCREW-ON FUEL FILTER

EQUIPMENT, TOOLS AND SUPPLIES

- Vehicle
- Large open end wrench to fit filter "nut"
- Tubing wrench for flare nut (if equipped)
- Pliers for spring clamp (if equipped)
- Rags
- Safety glasses
- Protective clothing
- Teflon tape (if required)
- Fender cover

PROCEDURE

Caution: This task must be performed outside or with an approved exhaust gases pickup hose connected to the tailpipe. All ignition sources must be eliminated from the immediate work area.

1. **Put on the safety glasses and protective clothing** then install the fender cover.

2. Remove the air cleaner to obtain access to the old fuel filter.

3. Place a rag under the old filter.

4. Remove the hose clamps and hose from the old filter

   OR

   Hold the filter with a large wrench and remove the line with a line wrench.

5. Loosen and remove the old fuel filter.

6. Wrap the new fuel filter threads with one and one-half counterclockwise wraps of teflon tape (if required).

7. Screw on the new fuel filter at least three turns by hand.
   Note: Overtightening or cross-threading this type of filter can ruin a carburetor.

8. Tighten filter with a wrench to prevent any fuel leaks.

9. Reinstall all lines or hoses.

10. **Remove and dispose of the gasoline soaked rag in the fireproof container.**

11. With your teacher's/supervisor's permission, start the vehicle to check for leaks. Shut off the vehicle immediately if any leaks are found. Retest after the leaks are repaired.

12. Shut off the vehicle if no leaks are detected after the engine has been running for about three minutes.

13. Clean and return all equipment, tools and supplies to their proper storage areas.

14. Clean up the work area.

15. Using the following chart as a guide, evaluate your performance.

	Excellent 4	Very Good 3	Good 2	Not Acceptable 1
The proper equipment, tools and supplies were selected.				
All steps in the procedure were completed.				
The filter was threaded in correctly.				
The filter connections did not leak.				
All related safety precautions were demonstrated.				
The equipment, tools and supplies were cleaned and returned to their proper storage areas.				
The work area was cleaned up.				

DISCUSSION TOPICS

1. How much "flat rate" time is allowed for fuel filter changes in the automotive industry?

2. Why should a liquid thread sealer not be used on screw-in filters?

3. What is required to repair?

JOB SHEET 16
CHANGING AN IN-CARBURETOR FUEL FILTER

EQUIPMENT, TOOLS AND SUPPLIES

- Vehicle
- Large wrench to fit filter "nut" or housing
- Line wrench to fit flare nut
- Safety glasses
- Protective clothing
- Fender cover
- Rag

PROCEDURE

Caution: This task must be performed outside or with an approved exhaust gases pickup hose connected to the tailpipe. All ignition sources must be eliminated from the immediate work area.

1. **Put on your safety glasses and protective clothing.**
2. Install the fender cover.
3. Place a rag under the line connection.
4. Hold the filter nut with a large wrench and loosen the flare nut with a line wrench.
5. Loosen and remove the filter nut.
6. Remove the old filter and spring.
7. Reinstall the spring, and then the new filter (with the check valve out).
8. Replace the gasket on the filter nut.
9. Reinstall the filter nut by turning it in clockwise at least three times by hand.

10. Carefully tighten filter nut to prevent leaks.

11. Install and tighten flare nut.

    Note: Be careful not to cross-thread or overtighten the filter housing or nut.

12. **Dispose of the gasoline-soaked rags in a fireproof container.**

13. With your teacher's/supervisor's permission, start the vehicle to check for leaks.

14. Clean and return equipment, tools and supplies to their proper storage areas.

15. Clean up the work area.

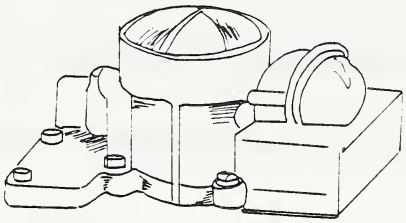
16. Using the following chart as a guide, evaluate your performance.

	Excellent 4	Very Good 3	Good 2	Not Acceptable 1
The proper equipment, tools and supplies were selected.				
All steps in the procedure were completed.				
The filter was installed in the correct direction.				
The filter nut was properly threaded in and tightened.				
All related safety precautions were demonstrated.				
The equipment, tools and supplies were cleaned and returned to their proper storage areas.				
The work area was cleaned up.				

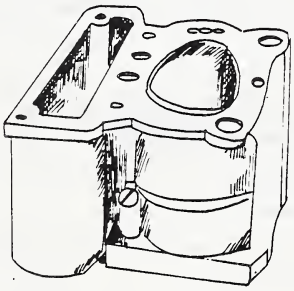
CARBURETORS

The carburetor, or "carb", is made up of three main sections:

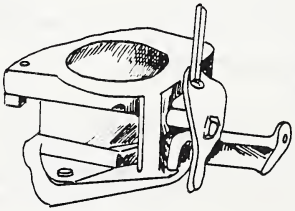
- **Air Horn** – covers the top of the carb and contains the choke valve.



- **Body** – contains all the passages for fuel travel, float bowl, and venturi.



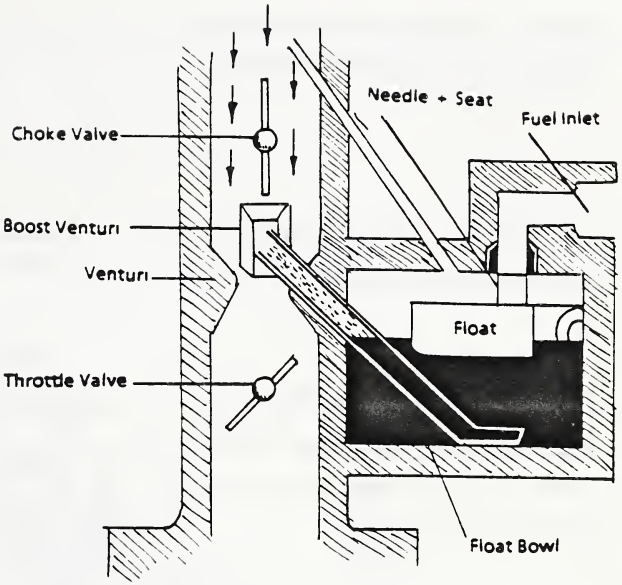
- **Throttle Body** – contains throttle valve, holds carb to intake manifold.



Other features of the carburetor include:

- Venturi – this is the narrow "hour-glass" shaped section of the carb throat used to speed up air flow. The number of venturis is used to describe the carb (a four barrel carb has four venturis).

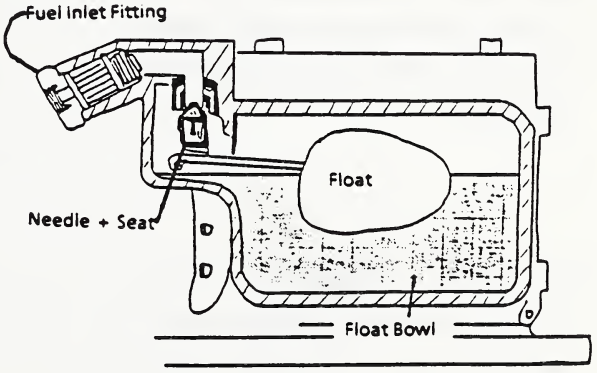
- Boost Venturi – this is an extra venturi placed above the main venturi. It speeds up air flow at a certain area of the carb.



- Float Bowl – stores fuel prior to use in the carb.

- Needle and Seat Valve – controls fuel flow into the carb float bowl.

- Float – senses fuel level in the bowl to open and close the needle and seat valve. It works on the same principle as a toilet tank float.



- Circuits – these are wormholes or tunnels in the carb control fuel flow.

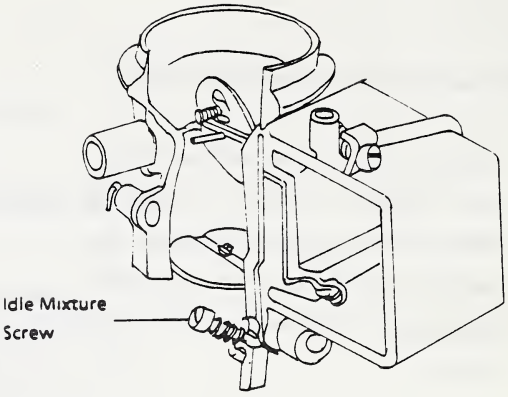
- Choke Valve – the top flap in the carb used to restrict air flow for cold starts.

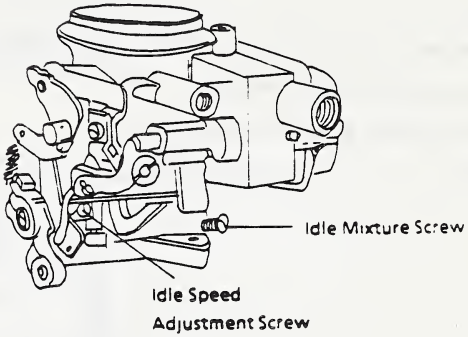
- Throttle Valve – bottom flap of carb connected to gas pedal through linkage. It controls air flow and engine speed (rpm).

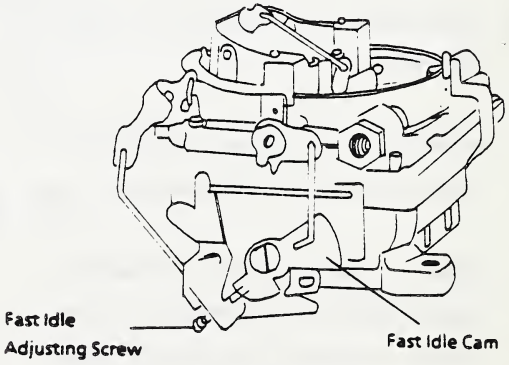
- Idle Mixture Screw – Adjusts air fuel mixture flow at idle speeds.

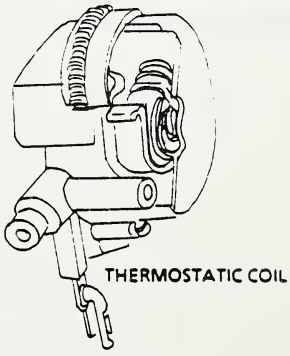
- Idle Speed and Adjustment Screw – controls the normal engine speed (curb idle) when the gas pedal is not depressed.

- Thermostatic Choke Coil – opens choke valve when the engine warms up.



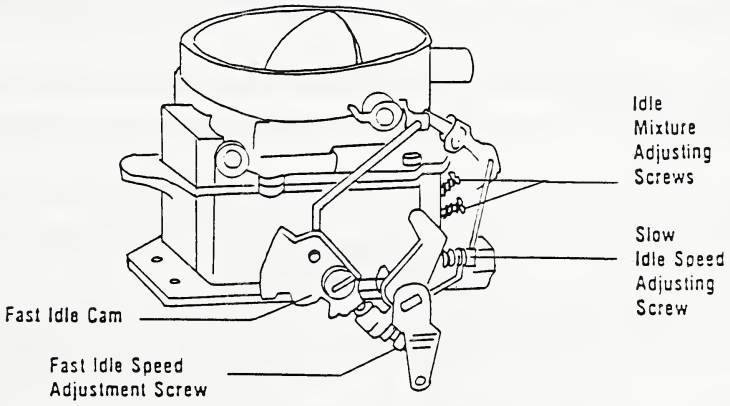






- Fast Idle Cam – opens throttle valve when the carburetor choke valve is closed.

- Fast Idle Speed Adjustment Screw – adjusts engine rpm during cold operation.



STUDENT ACTIVITIES

In your own words, describe the purpose of each of the following parts:

Venturi _____

_____

Boost venturi _____

_____

Air horn _____

_____

Circuits _____

_____

Carb body _____

_____

Float _____

_____

Needle and seat valve _____

_____

Throttle body _____

_____

Choke valve _____

_____

Throttle valve _____

_____

Idle mixture screw _____

_____

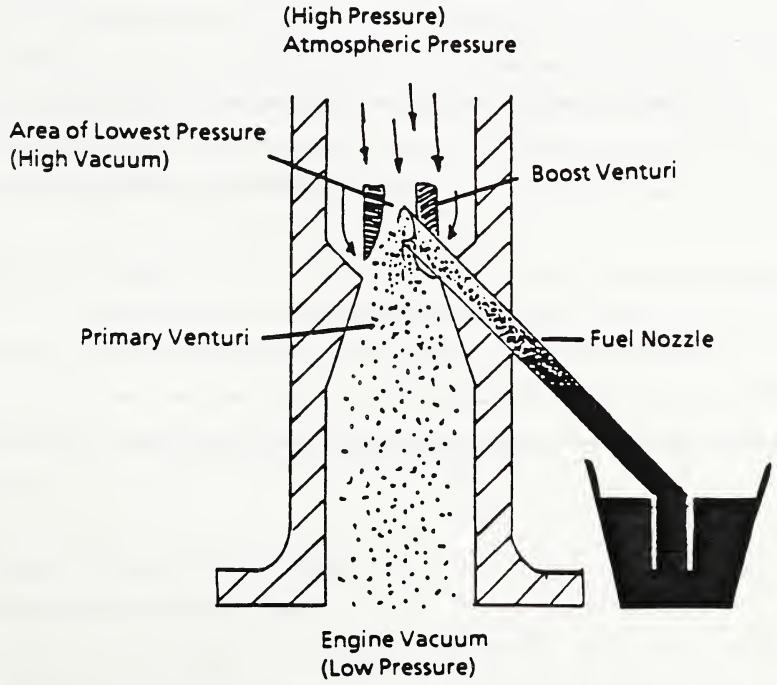
Idle speed adjustment screw _____

_____

VENTURI ACTION

Carburetors must provide the correct air/fuel mixture for many operating conditions. They meet this need by having different carburetor circuits provide the mixture at different times. The venturi is used to "pull" fuel out of the circuits by creating a difference in pressure.

As air rushes through the narrowed section of the venturi it speeds up. As the air speeds up, the pressure in this area drops below the original atmospheric pressure. The fuel in the float bowl is subjected to atmospheric pressure so the liquid gasoline travels "uphill" through the circuit to attempt to equalize the pressure imbalance. As the liquid gasoline arrives at the port or nozzle it enters the air stream to become the air fuel mixture.



STUDENT ACTIVITIES

In your own words, explain the meaning of the following terms:

RPM _____

_____

Choke valve _____

_____

Float bowl _____

_____

Fuel tank _____

_____

Venturi _____

_____

Fuel filter _____

_____

Fuel pump _____

_____

Four barrel carburetor _____

_____

JOB SHEET 17
ADJUSTING CURB IDLE SPEED

Curb idle speed refers to the normal running speed of an engine without the gas pedal depressed and at normal operating temperature. It is also referred to as the "slow idle" speed.

Curb idle speed is measured at the crank shaft in revolutions per minute (RPM). The curb idle speed adjustment is made by turning the idle speed adjustment screw. This screw slightly opens and closes the throttle valve. The speed of the engine is measured with a gauge called a **tachometer**.

EQUIPMENT, TOOLS AND SUPPLIES

- Vehicle with adjustable carburetor
- Screwdriver
- Tachometer
- Fender covers (2)
- Vehicle manual or under hood emission controls sticker information
- Safety glasses
- Protective clothing

PROCEDURE

Caution: Avoid contact with hot surfaces and moving parts during this operation.

1. **Put on the safety glasses and protective clothing.**

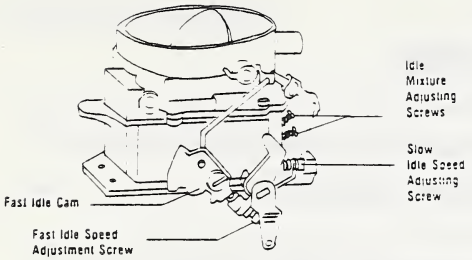
2. Install both fender covers.

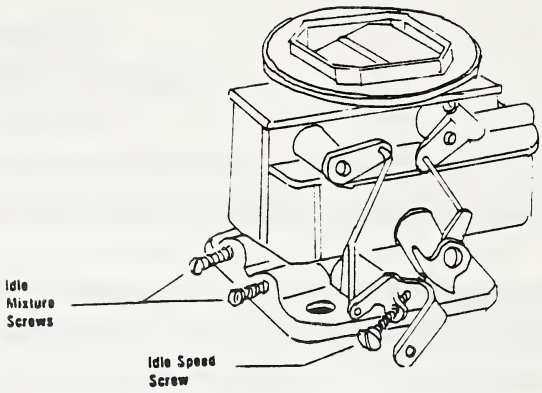
3. Ask your teacher/supervisor to demonstrate how to hook up the tachometer.

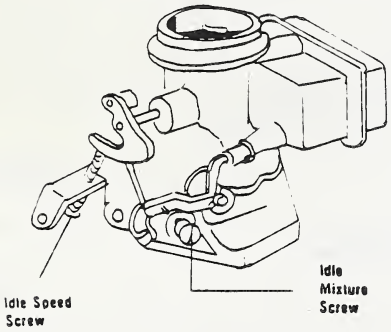
4. With your teacher's/supervisor's permission, start the vehicle to warm it up to operating temperature.

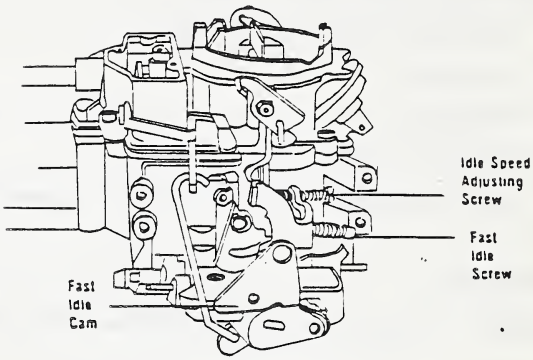
5. Check the shop manual or vehicle sticker to determine the correct curb idle speed.

6. Locate the idle speed adjustment screw.









7. Snap the throttle linkage open once very quickly to ensure that the choke is off.

8. Turn the idle speed adjustment screw to achieve the correct carb idle speed.

9. Have your teacher/supervisor check your work.

10. Clean and return equipment, tools and supplies to their proper storage areas.

11. Clean up the work area.

12. Using the following chart as a guide, evaluate your performance.

	Excellent 4	Very Good 3	Good 2	Not Acceptable 1
The proper equipment, tools and supplies were selected.				
All steps in the procedure were completed.				
The idle speed adjustment was correctly identified.				
The idle speed was set correctly.				
All related safety precautions were demonstrated.				
The equipment, tools and supplies were cleaned and returned to their proper storage areas.				
The work area was cleaned up.				

DISCUSSION TOPICS

1. How does idle speed affect performance?

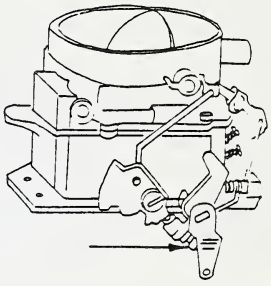
2. How does idle speed affect fuel economy?

JOB SHEET 18
ADJUSTING FAST IDLE SPEED

Fast idle speed refers to engine running speed during cold start conditions. The fast idle speed is also measured in RPM.

EQUIPMENT, TOOLS AND SUPPLIES

- Vehicle with carburetor
- Screwdriver
- Tachometer
- Fender covers (2)
- Safety glasses
- Protective clothing
- Vehicle repair manual



PROCEDURE

Caution: **Avoid contact with hot surfaces and moving parts during this job.**

1. **Put on the safety glasses and protective clothing.**

2. Install both fender covers.

3. Hook up the tachometer. (Ask your teacher/supervisor for assistance, if required.)

4. Locate the fast idle adjustment screw (see vehicle manual or curb idle job sheet).

5. Read the vehicle manual and the complete fast idle adjustment procedure.

   Note: The procedure shown is a general procedure. Different procedures may be used. Always follow the teacher's/ supervisor's or manufacturer's specific instructions.

   a. Hold the choke valve closed.
   b. Open the throttle to get the fast idle adjustment screw to sit on the second step of the fast idle.
   c. Start the vehicle without touching the gas pedal.
   d. Turn the fast idle adjustment screw to achieve the proper specification.

6. Snap open the throttle linkage to return to curb idle speed.

7. Shut off the engine.

8. Clean and return equipment, tools and supplies to their proper storage areas.

9. Clean up the work area.

10. Using the following chart as a guide, evaluate your performance.

	Excellent 4	Very Good 3	Good 2	Not Acceptable 1
The proper equipment, tools and supplies were selected.				
All steps in the procedure were completed.				
The fast idle adjustment screw was correctly identified.				
The fast idle speed was set correctly.				
All related safety precautions were demonstrated.				
The equipment, tools and supplies were cleaned and returned to their proper storage areas.				
The work area was cleaned up.				

DISCUSSION TOPICS

1. How is fast idle controlled on modern, fuel-injected vehicles?

2. How is the fast-idle speed adjusted on modern, fuel-injection systems?

JOB SHEET 19
ADJUSTING IDLE MIXTURE SCREWS

This operation is used to adjust the air/fuel mixture. It is critical for the idle mixture to be correctly adjusted to ensure smooth engine operation at idle and low speeds and to provide fuel economy.

EQUIPMENT, TOOLS AND SUPPLIES

- Vehicle with a carburetor
- Fender covers (2)
- Tachometer
- Vacuum gauge
- Screwdriver
- Safety glasses
- Protective clothing

PROCEDURE

Note: This set of instructions is intended for a vehicle equipped with a two-barrel carburetor. This carburetor must have adjustable and accessible mixture screws.

Caution: **Avoid contact with hot surfaces and moving parts during this operation.**

1. **Put on the safety glasses and protective clothing.**

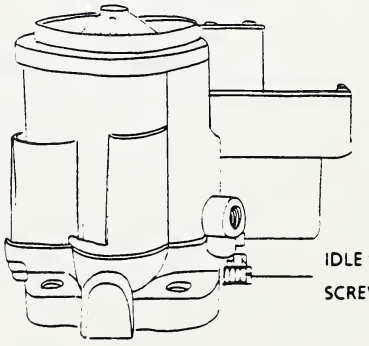
2. Install both fender covers.

3. Install the vacuum gauge and tachometer according to the teacher's/supervisor's or manufacturer's directions.

4. Start the vehicle with your teacher's/supervisor's permission.

5. Allow the vehicle to warm up and return to curb idle speed.

6. Locate both idle mixture adjustment screws.



7. Slowly, turn in one of the mixture screws until engine begins to miss (rapidly shake).

8. Counting the number of turns, unscrew the adjustment screw until the engine begins to roll (slowly shake).

9. Turn the screw to halfway between the miss and roll positions.

10. Carefully turn the screw in and out to achieve highest vacuum and RPM readings.

11. Repeat the procedure for second screw.

12. If the carb idle speed is not to specification, then adjust the idle speed and readjust the mixture adjustment screws.

13. Clean and return equipment, tools and supplies to their proper storage areas.

14. Clean up the work area.

15. Using the following chart as a guide, evaluate your performance.

	Excellent 4	Very Good 3	Good 2	Not Acceptable 1
The proper equipment, tools and supplies were selected.				
All steps in the procedure were completed.				
The mixture screws were properly identified.				
The mixture setting was correct.				
The idle speed was correct.				
All related safety precautions were demonstrated.				
The equipment, tools and supplies were cleaned and returned to their proper storage areas.				
The work area was cleaned up.				

JOB SHEET 20
INVESTIGATING MODERN CARBURETOR ADJUSTMENT

EQUIPMENT, TOOLS AND SUPPLIES

- Vehicle
- Adjustment tools
- Exhaust gas analyzer
- Pen or pencil

PROCEDURE

1. Observe the procedure for carburetor adjustment on a modern vehicle.

2. Complete the following information guide.

What equipment and tools were used? • • • • • • • •
What preparations were done before the actual adjustment procedure was started? • • • •
Were any specifications required? Record the specifications and where they can be found. _____ _____
What steps were followed during the adjustment? a. _____ b. _____ c. _____ d. _____ e. _____ f. _____ g. _____

What safety rules were followed during the adjustment?

-
-
-

How would the performance of this task be evaluated in industry?

DISCUSSION TOPICS

1. Why are fewer modern carburetors adjustable?

2. What types of modifications are performed to permit carburetor adjustment?

JOB SHEET 21
ADJUSTING A MODERN CARBURETOR

EQUIPMENT, TOOLS AND SUPPLIES

- A modern vehicle with an adjustable carburetor
- Suitable service information
- Exhaust gas pickup system
- Safety glasses
- Protective clothing
- Fender covers (2)

PROCEDURE

Caution: Avoid contact with hot surfaces and moving parts during this operation.

1. **Put on the safety glasses and protective clothing.**
2. **Connect the exhaust pickup hose to the tailpipe.**
3. Cover both front fenders with the fender covers.
4. With your teacher's/supervisor's permission, start the vehicle and allow the engine to warm up to operating temperature.
5. Look up the procedures and specifications for adjusting the carburetor idle speeds and mixture.
6. Record the required equipment, tools and supplies.
7. List the procedure below.

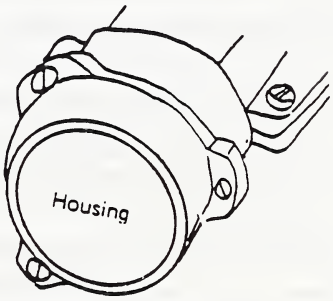
   a. _____
   b. _____
   c. _____
   d. _____
   e. _____
   f. _____
   g. _____

8. Complete the adjustment procedure.
9. Clean and return all equipment, tools and supplies to their proper storage areas.
10. Clean up the work area.
11. Evaluate your performance with the method recorded in the previous job sheet.

JOB SHEET 22
ADJUSTING AN AUTOMATIC CHOKE

EQUIPMENT, TOOLS AND SUPPLIES

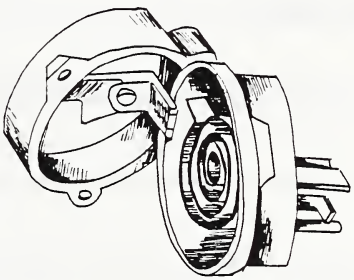
- Carburetor with adjustable choke
- Screwdriver
- Small parts tray
- Carburetor mounting stand
- Refrigerator or freezer (optional)



PROCEDURE

Note: This procedure is done to ensure proper cold start operation.

1. Mount the carburetor on a carburetor mounting stand.
2. Hold the choke valve flap closed, then open the throttle valve by turning the accelerator linkage.
3. Remove the screws and clamps from the automatic choke coil assembly.
4. Remove the automatic choke coil assembly.
5. Cool off the bi-metal spring coil with either cold water and compressed air OR by placing the coil in a freezer for about 4 or 5 minutes.



6. Reinstall the choke assembly. Make sure the spring engages linkage in housing.
7. Turn the choke housing lightly to close the choke valve.
8. Install and tighten the screws and clamps.
9. Clean and return the equipment, tools and supplies to their proper storage areas.
10. Clean up the work area.

11. Using the following chart as a guide, evaluate your performance.

	Excellent 4	Very Good 3	Good 2	Not Acceptable 1
The proper equipment, tools and supplies were selected.				
All steps in the procedure were completed.				
The choke coil was cooled for the proper time.				
The choke coil was properly reinstalled.				
The choke coil was properly adjusted.				
All related safety precautions were demonstrated.				
The equipment, tools and supplies were cleaned and returned to their proper storage areas.				
The work area was cleaned up.				

DISCUSSION TOPICS

1. How often should choke coils be readjusted?

2. What happens if the choke valve does not close on cold starts?

3. What happens if the choke valve stays closed for too long after a cold start?

4. What else can cause cold starting problems?

JOB SHEET 23
INVESTIGATING CARBURETOR OVERHAUL

EQUIPMENT, TOOLS AND SUPPLIES

- Pen or pencil
- Carburetor

PROCEDURE

1. Watch the teacher or automotive mechanic overhaul a carburetor, then answer the questions in the chart below.

	Observations
What type of carburetor was overhauled?	
What preparations did the mechanic make before starting to take off the carburetor?	
How was the carburetor held during disassembly?	
In what kind of a container did the mechanic put the parts to be cleaned?	
What was the liquid called that cleaned the carburetor?	
What was dangerous about the cleaning liquid?	

	Observations
How was the cleaning liquid washed off?	
Why did the mechanic remove parts before putting the carburetor in the cleaning liquid?	
What parts were replaced during the overhaul?	
After the carburetor was bolted to the engine what did the mechanic do?	
Why was the carburetor overhauled?	
What was the most difficult thing to do on a carburetor overhaul?	
How long did the overhaul take?	

DISCUSSION TOPICS

1. How much flat rate time is allowed for overhauling common carburetor types?

2. Is this type of operation performed on fuel injectors?

JOB SHEET 24
DISASSEMBLING AND REASSEMBLING A SIMPLE CARBURETOR

EQUIPMENT, TOOLS AND SUPPLIES

- Carburetor (1 or 2 bbl)
- Suitable tools
- Large flat parts tray
- Carburetor basket
- Carburetor cleaning solution
- Shop reference materials
- Carburetor kit
- Air blow gun
- Compressed air line
- Safety glasses
- Protective clothing
- Vinyl gloves

PROCEDURE

1. Study the construction of the carburetor and arrangements of the parts.
   Note: Pay particular attention to linkage positions and connections.

2. **Put on the safety glasses and protective clothing.**

3. Disassemble the carburetor according to the instructions.
   Note 1: Lay parts in the tray in the order in which you found them in the carburetor.
   Note 2: Do not use force when working on carburetors as they are easily damaged.

4. Have your teacher/supervisor check your work.

5. Carefully place all cleanable metallic parts in the carburetor basket.
   Note: Diaphragm's floats and valves will be destroyed by carburetor cleaner. Most plastic parts dissolve in carburetor cleaner.

6. **Put on the vinyl gloves.**

7. Carefully lower the carburetor into the cleaning solution.
   Caution: Rinse off any carburetor cleaning solution spills with plenty of warm water.

8. Replace the lid on the carburetor cleaner pail.
   Note: If the pail is equipped with an agitator, ask the teacher/supervisor to demonstrate the adjustment procedure.

9. Wait the required cleaning time.
   Note: Agitate the basket up and down occasionally if the pail is not equipped with an agitator.

10. **Wearing the safety glasses, protective clothing and vinyl gloves**, remove the basket from the cleaner.

    a. Remove the lid.

    b. Lift the basket and hook it over the inside of the pail to drain.

    c. Remove the basket when the excess liquid has drained from the basket.

    d. Replace the lid on the pail.

11. Rinse and air dry the carburetor according to your teacher's/supervisor's directions.
    Note: Do not blow away small parts.
    Caution: Do not blow the wet spray toward other people or vehicles.

12. Reassemble the carburetor with the gasket kit according to the instructions.

13. Pre-set the carburetor as directed in the gasket kit instructions.

14. Have the teacher/supervisor inspect your work.

15. Clean and return all equipment, tools and supplies to their proper storage areas.

16. Clean up the work area.

17. Using the following chart as a guide, evaluate your performance.

	Excellent 4	Very Good 3	Good 2	Not Acceptable 1
The proper equipment, tools and supplies were selected.				
All steps in the procedure were completed.				
Only the cleanable parts were placed in the basket.				
The carburetor was cleaned.				
The carburetor was properly pre-adjusted.				
The linkage did not bind when operated.				
All related safety precautions were demonstrated.				
The equipment, tools and supplies were cleaned and returned to their proper storage areas.				
The work area was cleaned up.				

DISCUSSION TOPICS

1. What do carburetor overhauls cost in repair shops?

2. What is the cost of rebuilt carburetors?

3. What carburetor problems prevent overhauling?

4. What emission control devices are encountered during carburetor overhauls?

AUTOMOTIVE TIRES

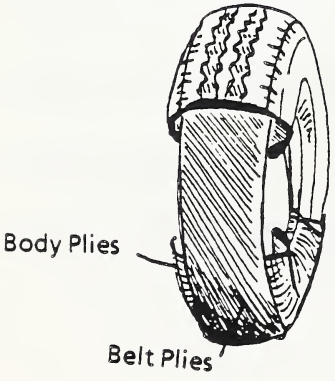
Tires on the vehicle perform three main functions:

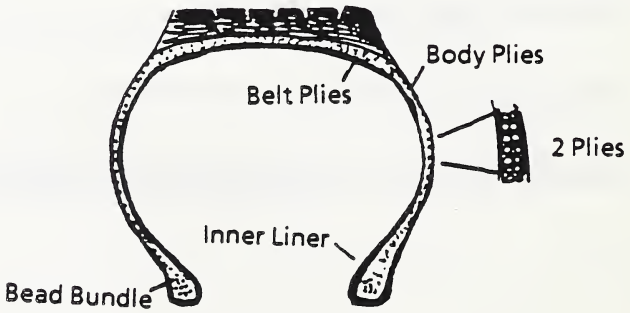
- provide traction
- absorb road shock
- support vehicle weight.

CONSTRUCTION

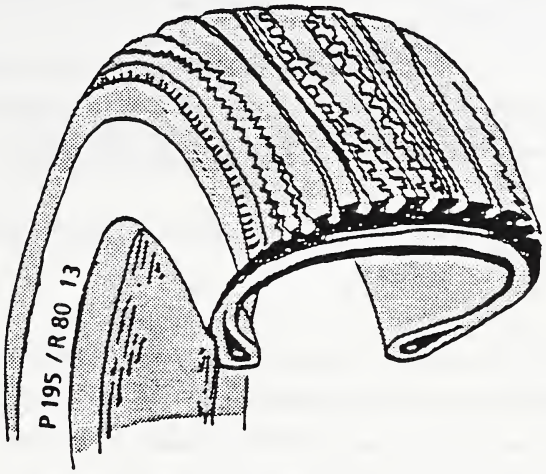
All tires have the same basic components:

- Soft Inner Liner – This replaces the tube and tends to seal around objects puncturing the tire tread.
- Bead Bundle – A collection of strong steel wires that prevents the tire from stretching off the rim.
- Body Plies – Layers of fabric that hold the tire together and support the air pressure.
- Belt Plies – Layers of fabric support the tread and resist flexing.

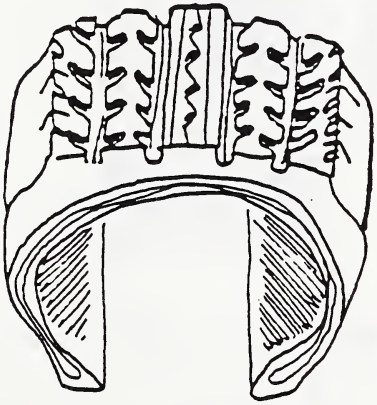




- Side Walls – The outer rubber layer seals at bend area and tread stock. They also provide a location for information stamping.



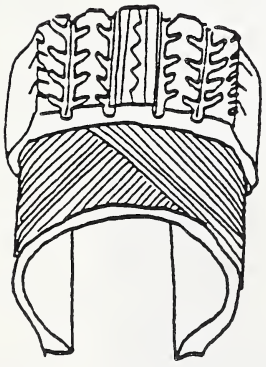
- Tread Stock – The thick section of rubber that provides the grip for road traction.



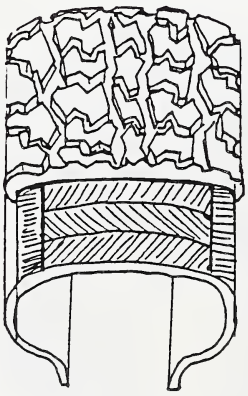
TYPES OF TIRE CONSTRUCTION

Construction type refers to the arrangement of the plies during the tire's manufacturing process. There are three types of tire construction:

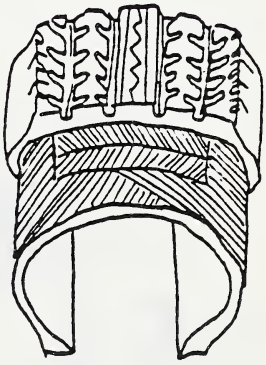
- Bias Tire – A bias tire does not have belt plies and its body plies run diagonally from bead to bead. This construction type is seldom used on vehicles today.
- Bias Belted Tire – A bias belted tire has diagonal body plies plus one or more belt plies to support the tread.
- Radial Tire – This is the most common tire on modern vehicles. It often has body plies that run at 90° to the bead areas. Most radial tires will have additional belt plies. This tire is very flexible sideways which allows the tread to stay on the road surface for improved traction and handling.



Bias



Radial



Belted Bias

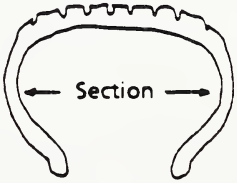
SIZE CODES

The information on the sidewall of the tire must be matched to vehicle design standards. This is important information to the automotive mechanic.

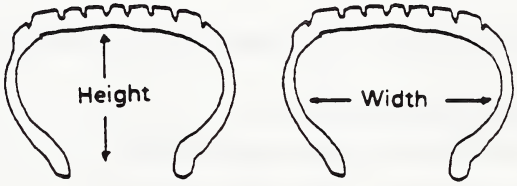
There are two tire codes, the metric and the imperial codes.

- The Metric Tire Code – This is the most commonly used tire code. This code includes the following information:

Tire Type
P – passenger
T – temporary
C – commercial



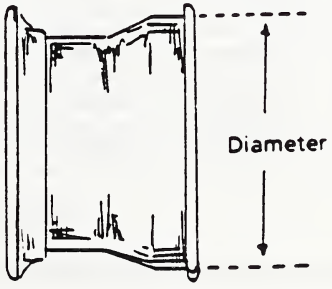
Section Width in mm
175
185
195
205
215
225



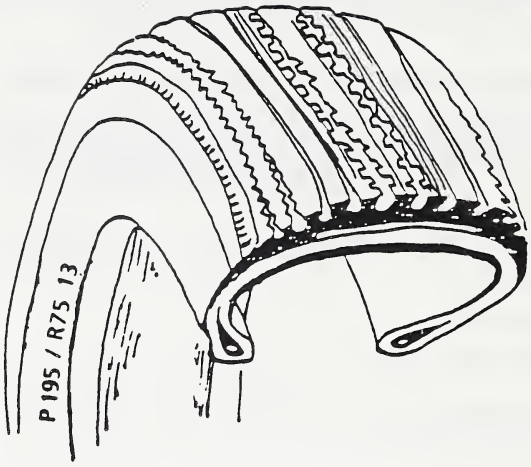
Aspect Ratio (height/width) in %
60
70
75
78

Construction Type
D – bias
B – bias belted
R – radial

Rim Diameter
12
13
14
15
16
16.5



Example: Tire Code: P195 R75/13
P – Tire Use – "P" for passenger car
195 – Section Width – 195 mm interior width
R – Tire Construction – R for radial
75 – Aspect Ratio – Height is 75% width
13 – Rim Size – 13 inch diameter rim.



- Imperial Tire Code – The imperial code provides limited information:

Example: Tire Code: H78-14
H – Letter code for section width of 8.25"
78 – Aspect ratio – height 78% of the width
14 – Rim Diameter of 14"

The following chart shows size comparisons for metric and imperial tire codes.

Bias and Belted Bias Ply Tires with Imperial Codes		Radial Ply Tires with Imperial Code		Radial PLY Metric	
B78-13	B70-13	BR78-13	BR70-13	P165R80/13	P185R70/13
D78-14	D70-14	DR78-14	DR70-14	P195R75/14	P205R70/14
E78-14	E70-14	ER78-14	ER70-14	P205R75/14	P215R70/14
G78-14	G70-14	GR78-14	GR70-14	P215R75/14	P225R70/14
G78-15	G70-15	GR78-15	GR70-15	P215R75/15	P225R70/15
H78-15	H70-15	HR78-15	HR70-15	P225R75/15	P235R70/15

TIRE SIZE COMPARISON CHART

Note: The majority of tires carry the metric tire code.

STUDENT ACTIVITIES

1. Copy the tire codes from the sidewalls of two vehicles: one with metric radial tires and one with imperial belted bias tires. Provide an explanation of what each code means.

   a. Metric Radial Tire Code

      Type of vehicle – _____

      Code on sidewall – _____

      Explanation: _____
      _____
      _____

   b. Imperial Belted Bias Tire Code

      Type of vehicle – _____

      Code on sidewall – _____

      Explanation: _____
      _____
      _____

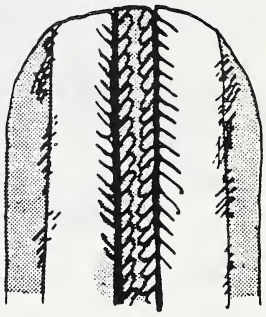
2. Discuss: "What are the advantages and disadvantages of using radial as opposed to belted bias tires?" Record the major points from the discussion.

   _____
   _____
   _____
   _____

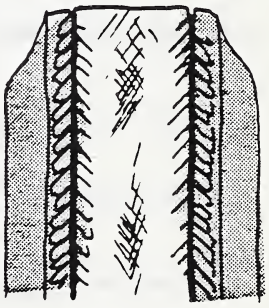
WEAR DIAGNOSIS

Several problems can be detected by inspecting the tread surface of tires for unusual wear patterns. Normally, a tire tread should wear flat and evenly, however the following patterns are commonly found:

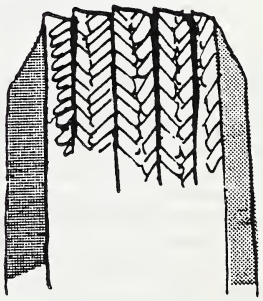
- Shoulder Wear – Caused by under inflation. Without sufficient air pressure to support the weight of the vehicle, the centre of the tread buckles in and excess pressure is put on the outside edges of the tread surface.



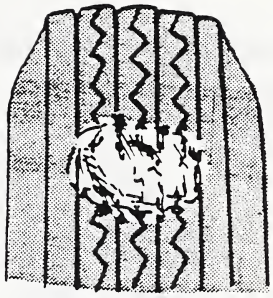
- Centre Section Wear – Caused by over inflation. The centre of the tread is bulged out against the road surface and wears prematurely.



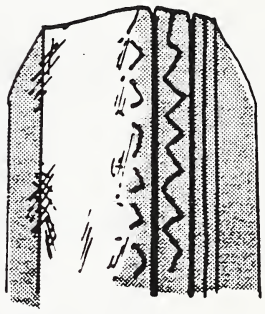
- Feathered Edge Wear – Caused by toe in or out excesses. The rubber is wiped off the tread in the direction of excess toe.



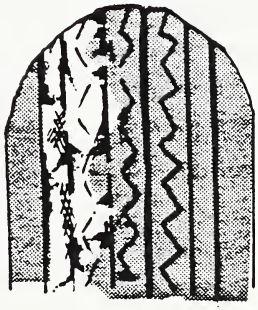
- Cupping Wear – Caused by excessive tire imbalance. The heavy spots hit the road surface and wear away leaving a cupped section.



- Camber Wear – Caused by improper wheel alignment.



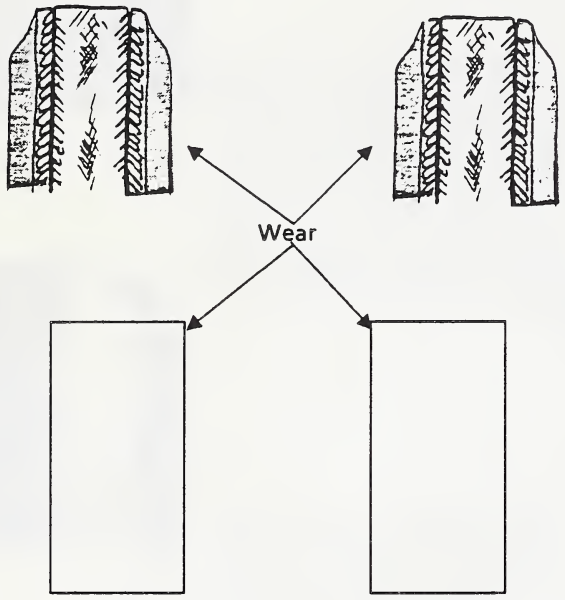
- Cornering Wear – Caused by the use of power steering and excessively fast turns which wear away the shoulder of the tread stock and scuff the sidewall.



STUDENT ACTIVITIES

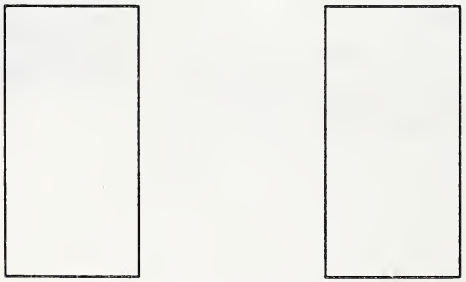
1. Identify three vehicles with tire wear problems, draw simple diagrams and explain the causes of the problems.

   e.g.,



Tire Location – front
Vehicle Description – 1983 Malibu station wagon
Tire Type – Radial
Diagnosis – over inflation: both tires.

Tire Location _____
Vehicle Description _____
Tire Type _____
Diagnosis _____

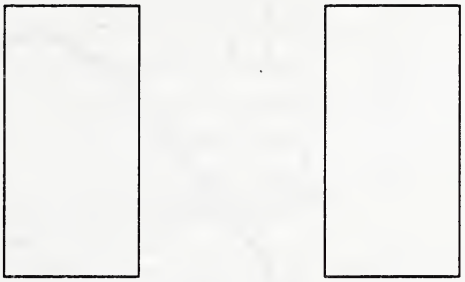


Tire Location _____

Vehicle Description _____

Tire Type _____

Diagnosis _____



Tire Location _____

Vehicle Description _____

Tire Type _____

Diagnosis _____

2. Why is it dangerous to drive with worn tires?

_____

_____

_____

3. How frequently should tires be inspected for wear? Why?

_____

_____

_____

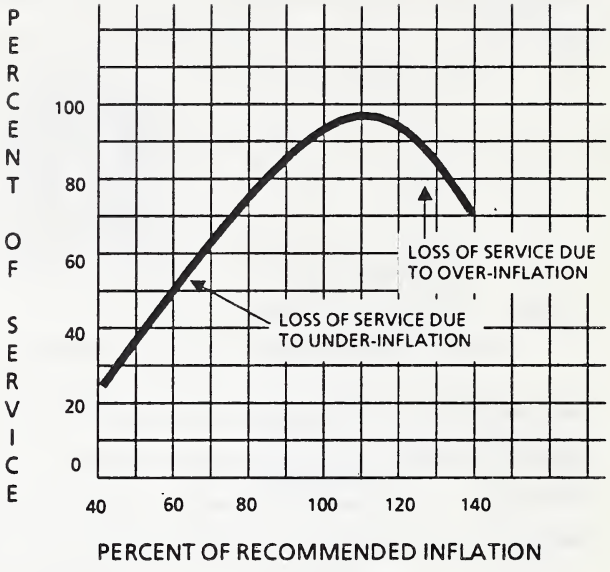
INFLATION

CHECK AND ADJUST TIRE PRESSURES

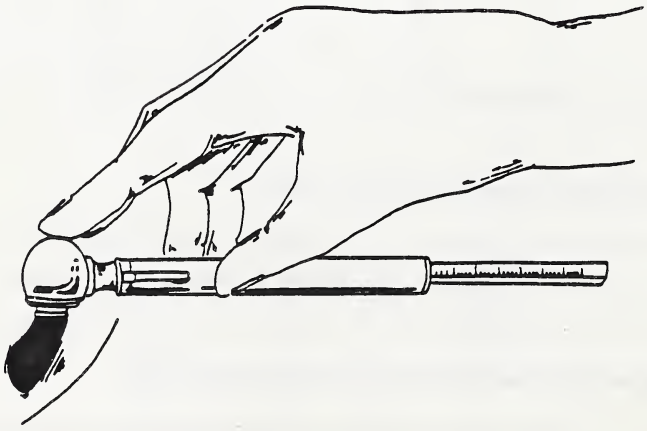
Improper tire inflation is the most common cause of tire wear found in the auto industry. The graph illustrates how a tire inflated to only 60% of specified pressure will lose 50% of the expected service life.

It is not uncommon to check tire pressures and find that they are under or over inflated by 50% of specified pressure. Tire pressures should be checked monthly when the tires are cold.

Pressure is commonly measured in pounds per square inch (psi) and may also be referred to in terms of kilopascals (kPa).



The Relationship Between Tire Pressure and Tire Life



Graph from: *Automotive Technology* by Fredrick C. Nash, page 117. Copyright 1986, McGraw-Hill Ryerson. Reprinted with permission.

JOB SHEET 25
ADJUSTING TIRE INFLATION

EQUIPMENT, TOOLS AND SUPPLIES

- Vehicle
- Tire gauge
- Tire chuck
- Air hose
- Safety glasses
- Protective clothing

PROCEDURE

1. **Put on the safety glasses and protective clothing.**

2. Determine the tire inflation specifications by locating the inflation sticker on the vehicle door post, door or glove box. If the sticker is missing, look the specification up in the owner's manual or a shop reference. Record the specifications on the tire pressures chart below.

TIRE PRESSURES CHART	
CURRENT PRESSURES	
LF ___ psi	RF ____ psi
LR ___ psi	RR ____ psi
	SPARE ____ psi
SPECIFIED PRESSURES	
	FRONT ____ psi
	REAR ____ psi
	SPARE ____ psi

3. Check the pressure of each tire and record the current pressures on the chart.
   Note: Hold the gauge so air from the tire is directed into the gauge. A hissing sound indicates that the angle of the gauge should be moved to get an accurate reading.

4. Adjust the tire pressures, including the spare tire, to the specified pressures.
   Note: Inflate tires in short bursts and check pressure frequently to prevent over inflation.

5. Clean and return the equipment, tools and supplies to their proper storage areas.

6. Using the following chart as a guide, evaluate your performance.

	Excellent 4	Very Good 3	Good 2	Not Acceptable 1
The proper equipment, tools and supplies were selected.				
All steps in the procedure were completed.				
The proper inflation specifications were determined.				
The tires were adjusted to the correct inflation pressures.				
All related safety precautions were demonstrated.				
The equipment, tools and supplies were cleaned and returned to their proper storage areas.				
The work area was cleaned up.				

DISCUSSION TOPICS

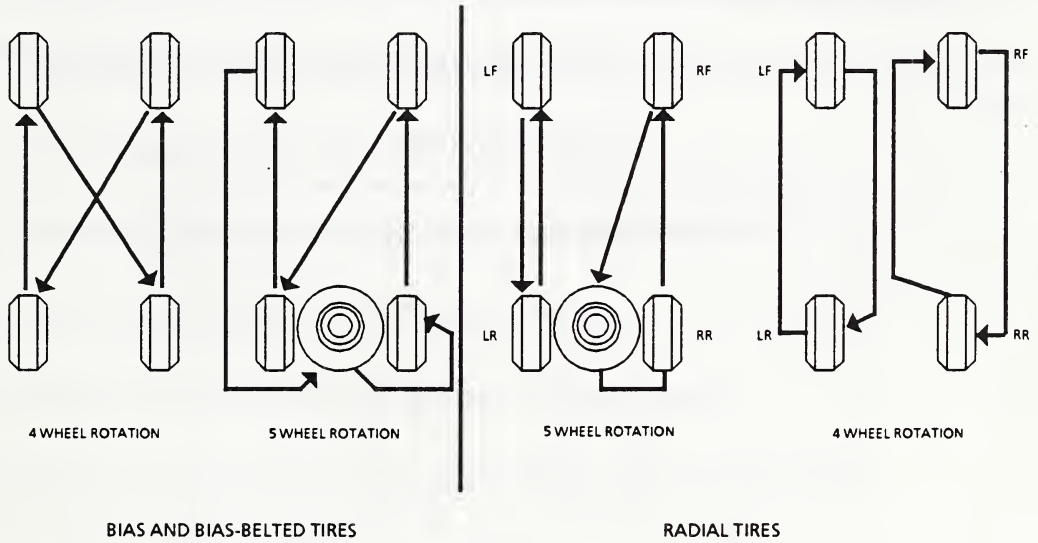
1. Share the original pressure readings with your classmates. Compose a graph illustrating how common improper tire inflation is on these sample vehicles.

2. How is improper tire inflation related to environmental damage?

TIRE ROTATION

The term "tire rotation" refers to the moving of entire wheels (tires and rims) to different locations on the vehicle to spread tire wear evenly. The front tires of the vehicle tend to wear on the sides more quickly from cornering; the rear tires tend to wear in the centre of the tread from carrying heavy loads.

It is important to know the type of tire construction. Radial tires develop a rolling pattern and should therefore only be rotated back and forth on the same side of any vehicle. The rotation pattern of radial tires is, therefore, different from the pattern used with bias and bias-belted tires. The following diagrams show the proper rotation pattern for each type of tire.



TIRE ROTATION PATTERNS

Note: When performing a tire rotation that includes the spare tire, be sure to write on the "new" spare tire where it came from.

JOB SHEET 26
PERFORMING A TIRE ROTATION

EQUIPMENT, TOOLS AND SUPPLIES

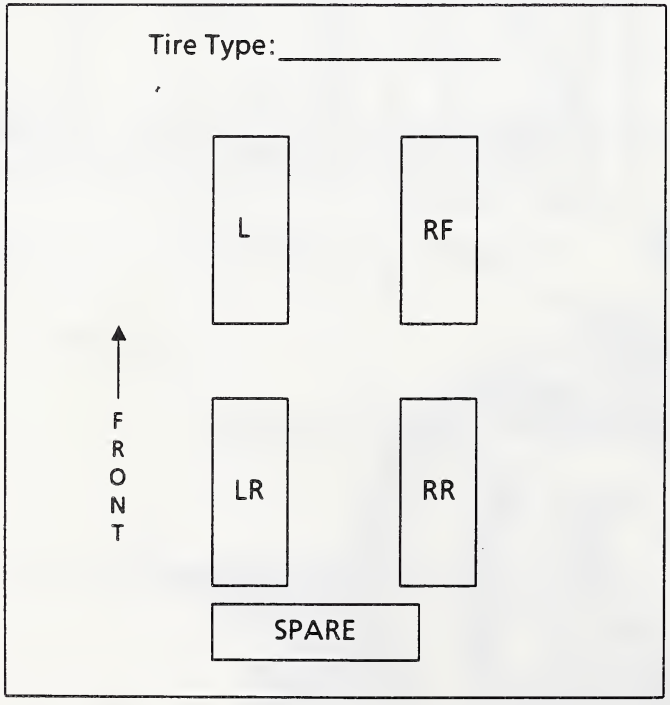
- Vehicle
- Floor jack
- Jack stands
- Wheel wrench
- Standard screwdriver
- Torque wrench
- Socket set
- Safety glasses
- Protective clothing

PROCEDURE

1. **Put on the safety glasses and protective clothing.**

2. Identify the tire construction type and draw the proper rotation pattern on the tire rotation chart.

TIRE ROTATION CHART



3. Remove all of the hubcaps and place them beside the vehicle, with the chrome side up.

4. Loosen all of the lug nuts one half turn (counterclockwise for most vehicles).

5. **Raise the vehicle with a floor jack and then safely support the weight of the vehicle on the jack stands.**

6. Remove all of the tires.

7. Inspect all tires for any wear, cuts, damage and proper inflation pressure.

8. Call your teacher's/supervisor's attention to any major problems.

9. Install the tires at the proper new locations as indicated by the rotation pattern diagram.

10. Install all of the lug nuts by hand and snug them up with the wheel wrench.

11. Let the vehicle down onto its tires.

12. **Tighten the lug nuts, using the proper pattern and torque specifications.**

13. Have the teacher or supervisor check the lug nuts torque.

14. Install all of the hubcaps, making sure that the valve stems protrude.

15. Clean and return all equipment, tools and supplies to their proper storage areas.

16. Clean up the work area.

17. Using the following chart as a guide, evaluate your performance.

	Excellent 4	Very Good 3	Good 2	Not Acceptable 1
The proper equipment, tools and supplies were selected.				
All steps in the procedure were completed.				
The proper tire rotation pattern was selected.				
The tires were rotated to the proper position.				
All major problems were reported.				
The lug nuts were torqued properly.				
All related safety precautions were demonstrated.				
The equipment, tools and supplies were cleaned and returned to their proper storage areas.				
The work area was cleaned up.				

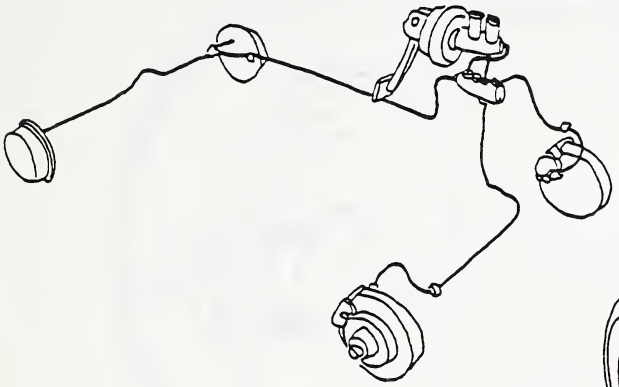
DISCUSSION TOPICS

1. How long would this task take in a tire shop?

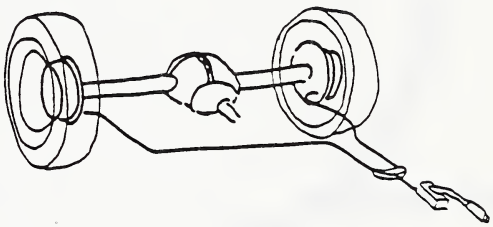
2. What could happen if excessive torque was applied to the lug nuts?

AUTOMOTIVE BRAKES

Two braking systems are used to stop a vehicle: the service and the emergency or park brakes.



SERVICE BRAKES



EMERGENCY BRAKES

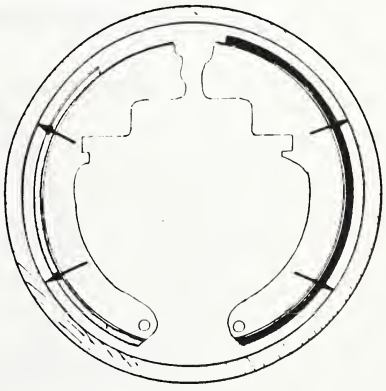
Service brakes are the main brakes of a vehicle.

The emergency or park brakes only apply to the vehicle's rear. A system of mechanical levers and cables pull on the same rear brake units used by the service brakes. This system is used to hold the vehicle while parked and as a standby should the service brakes fail.

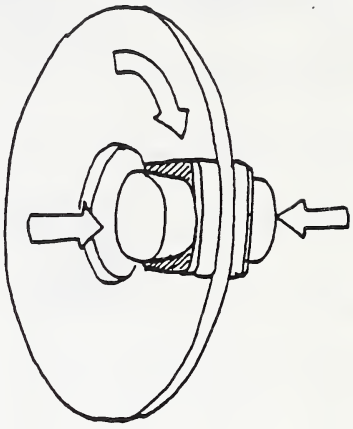
TYPES OF BRAKE UNITS

Two types or designs of brake units are found on modern vehicles.

- Drum Brake Units – These are normally found at the rear of the vehicle. Each unit has two shoes that are forced out to touch a revolving drum. As the shoes rub on the drum, the vehicle is stopped.



- Disc Brake Units – This design is normally found on the front of the vehicle. It consists of a hydraulic "C" clamp that squeezes two pads against a spinning rotor. Friction develops between the pads and rotor to stop the vehicle.

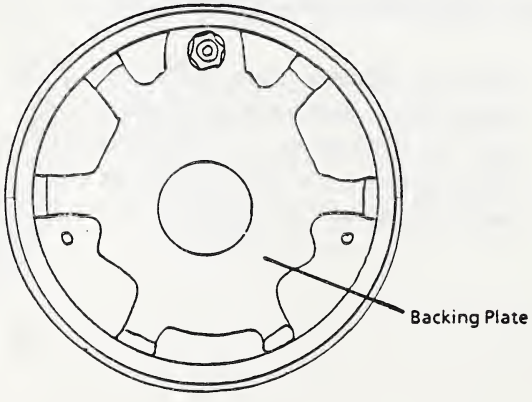


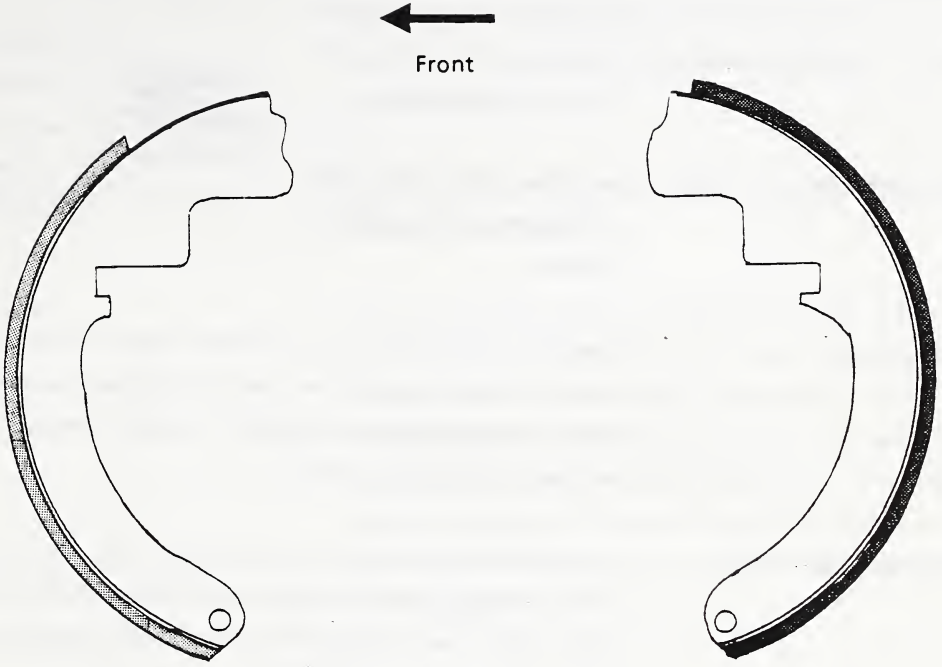
DRUM BRAKES

The drum brake units are made up of the following parts.

- Backing Plate – Holds the parts in their proper place.

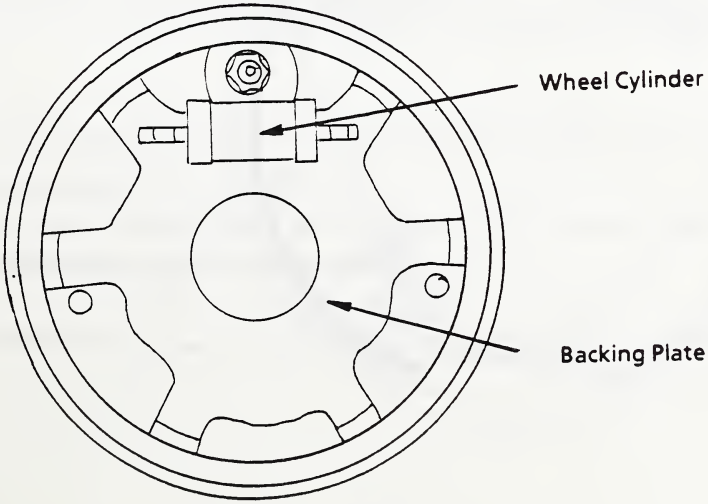
- Brake Shoes – Brake shoes are made of an asbestos lining attached to a steel shoe. Drum brake units have two shoes that rub on the inside of the drum. Each shoe is different and can be identified by position and lining length. The front shoe with the short lining is called the primary shoe. The rear shoe with the longer lining is called the secondary shoe.



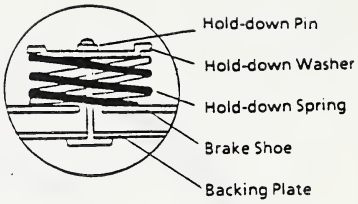


It is important to recognize these shoes as they must be in their correct location for the brakes to work properly.

- Wheel Cylinder – Sits at the top of the unit and pushes the shoes apart.



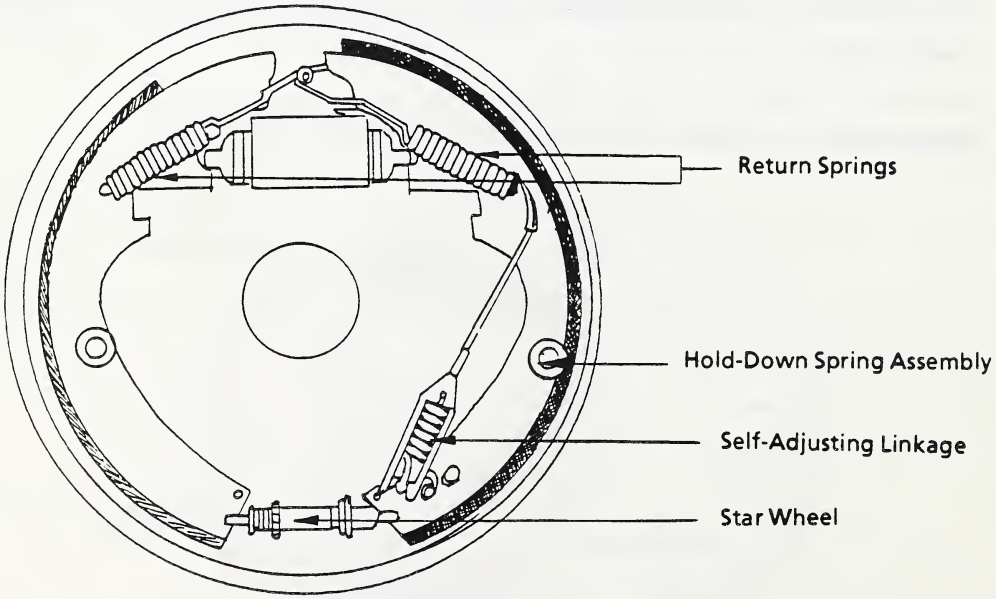
- Hold-Down Spring Assembly – An assembly consisting of a pin, springs, and washers for each shoe holds each shoe against a backing plate.



- Return Springs – Pull the shoes back into place when a brake pedal is released.

- Brake Adjuster – Keep the shoe linings a set distance away from each drum surface. They are required because the lining wears away slightly every time the brakes are applied. The most common type of adjuster is called a "star wheel".

- Self-Adjusting Linkage – A collection of parts that turn or "adjust" the adjuster if the lining wear has created too large a gap between the shoes and drum. These parts move when the vehicle is backing up and when sharply applying the brakes.



- Emergency or Park Brake Linkage – Spread the shoes when the emergency brake is applied. It consists of a cable through the backing plate, an arm attached to the secondary shoes and a steel bar and spring between the shoes.

- Brake Drum – Spins with the wheel and provides a smooth inner friction surface for the shoes.

- Brake Fluid – The special liquid inside an automotive brake system. It must not be mixed with any other liquids. Oil contamination in the brake system ruins all rubber components and can cause brake failure. This fluid level is checked at the master cylinder reservoir. It should be checked regularly and filled with new brake fluid to the full mark on plastic reservoirs or to within 15 mm from the top of cast reservoirs.

SERVICING BRAKES

Removing and replacing brake shoes is a common job for the automotive mechanic. When working on drum brake systems, observe the following safety and work area standards:

- Carefully follow directions on how to properly pre-clean brake units to avoid breathing in asbestos dust from the brakes.

- Keep the work area neat and organized. Place parts in trays to correspond to their mounting arrangement.

- Keep hands and tools clean at all times to prevent contamination of the linings on the shoes.

- Use care when working with springs. Move tools carefully to control spring pressure and to prevent springs from snapping off in a dangerous manner.

JOB SHEET 27

REMOVING AND REPLACING BRAKE SHOES ON A SIMPLE DRUM BRAKE UNIT

EQUIPMENT, TOOLS AND SUPPLIES

- Simple drum brake unit
- Hold-down spring tool
- Return spring tool
- Brake adjuster "spoon"
- Parts tray
- Rag
- Safety glasses
- Protective clothing
- Backing plate lubrication

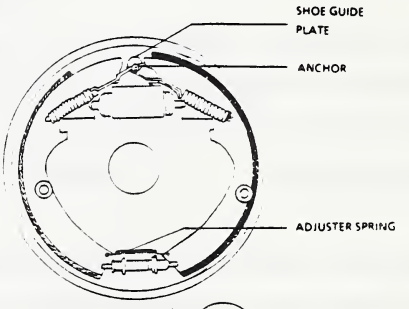
PROCEDURE

This operation can only be performed on operational vehicles by, or under supervision of, a certified motor mechanic.

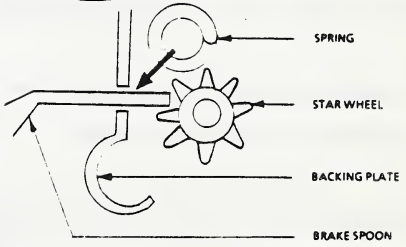
A. REMOVAL

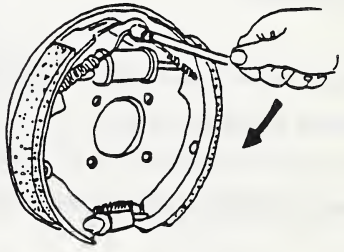
1. **Put on the safety glasses and protective clothing.**

2. Use the brake spoon to turn the star wheel to the shortest length possible.



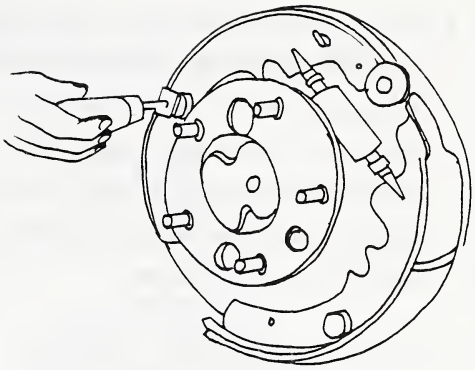
3. Remove the primary shoe return spring with the return spring tool. Place the end of the tool over the anchor and turn the tool to pick up the end of the spring. Carefully tilt the outer end of the tool toward the spring attachment point on the shoe to reduce spring tension. Let the return spring tool slide off the end of the anchor.





4. Remove the secondary shoe return spring in the same way that you removed the primary shoe return spring.

5. Remove the primary shoe hold-down spring assembly with the hold-down spring tool. Press the end of the hold-down pin against the backing plate with one hand and compress the spring with the tool in the other hand. One quarter turn will release the washer from the pin. The assembly can then be removed.



6. Pull the top end of the secondary shoe out slightly and move it toward the secondary shoe. This will release pressure on the adjuster spring, allowing the star wheel adjuster, adjuster spring and primary shoe to be removed.

7. Remove the secondary shoe hold-down spring assembly.

8. Remove the shoe guide plate.

9. Carefully arrange your parts in a tray for the teacher's/supervisor's inspection.

When you have your teacher's/supervisor's permission, proceed to the installation section.

B. INSTALLATION

Caution: If the brakes are not assembled correctly, the vehicle's braking action will be hampered. Your work must be 100% right to ensure vehicle safety.

1. **Make sure all parts and tools are clean.**

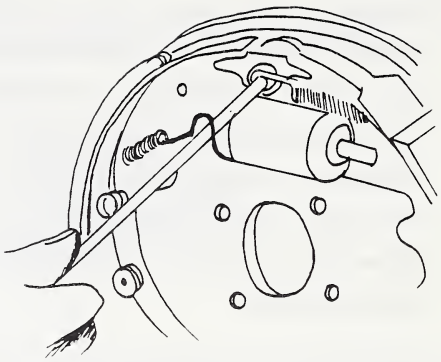
2. Lubricate the backing plate pedestals as directed by your teacher/supervisor.
   Caution: Apply a minimum amount of specialized, high temperature grease.

3. Install the secondary shoe hold-down spring assembly. Place the secondary shoe in position on the backing plate and hold it in place with your thumb. Insert the hold-down pin and hold it in place with your fingers on same hand. With other hand, install the spring and washer using a hold-down tool. Make sure the flattened end of the pin is locked into the low spot in the washer.

4. Install the primary shoe and hold-down spring assembly.

5. Install the shoe guide plate.

6. Install the secondary shoe return spring. Hook the end of the spring into the shoe and place the other end of the spring over the return spring tool shaft. Place the return spring tool notch over the anchor and stretch the spring to snap into place over the end of the anchor.



7. Install the primary shoe return spring.

8. Install the adjuster spring between shoes.

9. Spread the bottom of shoes apart and install the star wheel adjuster. Use the brake spoon to turn the star wheel three or four turns and tension the adjuster spring.

10. **Have your teacher/supervisor check your work.**

11. Clean and return all equipment, tools and supplies to their proper storage areas.

12. Clean up the work area.

13. Using the following chart as a guide, evaluate your performance.

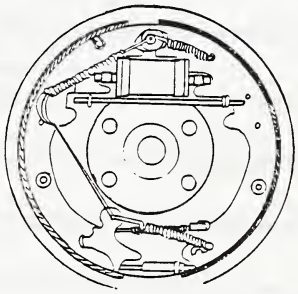
	Excellent 4	Very Good 3	Good 2	Not Acceptable 1
The proper equipment, tools and supplies were selected.				
All steps in the procedure were completed.				
The shoes were properly removed.				
The shoes were properly installed.				
All related safety precautions were demonstrated.				
The equipment, tools and supplies were cleaned and returned to their proper storage areas.				
The work area was cleaned up.				

JOB SHEET 28

REMOVING AND REPLACING BRAKE SHOES ON A BENDIX BRAKE UNIT

EQUIPMENT, TOOLS AND SUPPLIES

- Bendix brake unit
- Jack stands (4)
- Floor jack
- Return spring tool
- Hold-down spring tool
- Standard blade screwdriver (or welding rod)
- Brake spoon
- Service manual for brake system
- Rags
- Safety glasses
- Protective clothing
- Backing plate lubricant



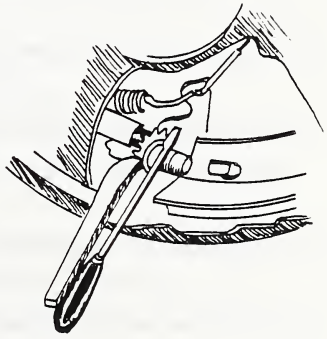
PROCEDURE

This operation can only be performed on operational vehicles by, or under supervision of, a certified motor mechanic.

A. REMOVAL

1. **Put on the safety glasses and protective clothing.**

2. Support the vehicle safely on jack stands and remove all of the wheels.
   Note: Ensure that the emergency brake is off.



3. Turn both star wheels to their shortest length. Push the adjuster lever away from the star wheel with the screwdriver; turn the star wheel with the brake spoon.

4. Remove the brake drum. If the drum seizes, ask your teacher/supervisor for assistance.

5. Clean the brake components as directed by your teacher/supervisor.

6. Pry the adjuster levers up and unhook both adjuster cables.

7. Pull the bottom of the shoes apart to remove the star wheel.
8. Push the bottom of the shoes together to unhook them and then remove the adjuster lever return spring.
9. Remove the adjuster lever.
10. Remove the primary shoe return spring.
11. Remove the primary shoe hold-down spring assembly and primary shoe.
12. Remove the park brake link and link spring.
13. Remove the secondary shoe return spring.
14. Remove the secondary shoe hold-down spring assembly.
15. Unhook the secondary shoe from the emergency brake cable.
16. Remove the park brake lever and cable guide from the secondary shoe if directed to do so by your teacher/supervisor.
17. Arrange the parts and have your teacher/supervisor check your work.

B. INSTALLATION

Caution: If the brakes are not assembled correctly, the vehicle's braking action will be hampered. Your work must be 100% right to ensure vehicle safety.

1. Make sure that your parts, tools and hands are clean.
2. Lubricate the backing plate pedestals as directed by your teacher/supervisor.
   Caution: Apply a minimum amount of specialized, high temperature grease.
3. Install the cable guide on the secondary shoe (if it was removed).
4. Install the park brake lever on the secondary shoe if it was removed.
5. Hook the park brake lever to the emergency brake cable.
6. Mount the secondary shoe on the backing plate with the hold-down spring assembly.

7. Install the shoe guide on the anchor.

8. Install the adjuster cable on the anchor with the end pointing toward the secondary shoe.

9. Install the secondary shoe return spring.

10. Position the park brake link and spring against the secondary shoe.

11. Install the primary shoe with the hold-down spring assembly.

12. Install the primary shoe return spring.

13. Install the star wheel adjuster.

14. Hook the adjuster spring to the primary shoe.

15. Hook the adjuster lever to the secondary shoe.

16. Hook the end of the adjuster spring to the adjuster lever.

17. Pry the adjuster lever up and hook it to the cable.
    Note: Make sure the cable is sitting on the cable guide.

18. **Have your teacher/supervisor check your work.**

19. Install the brake drum.
    Note: Adjust the brakes if directed by your teacher/supervisor.

20. **Install the wheel and torque lug nuts.**

21. Clean and return all equipment, tools and supplies to their proper storage areas.

22. Clean up the work area.

23. Using the following chart as a guide, evaluate your performance.

	Excellent 4	Very Good 3	Good 2	Not Acceptable 1
The proper equipment, tools and supplies were selected.				
All steps in the procedure were completed.				
The shoes were installed in the correct position.				
The brake unit was reassembled properly.				
All related safety precautions were demonstrated.				
The equipment, tools and supplies were cleaned and returned to their proper storage areas.				
The work area was cleaned up.				

JOB SHEET 29

REMOVING AND REPLACING BRAKE SHOES ON A DELCO MORRAINE BRAKE UNIT

EQUIPMENT, TOOLS AND SUPPLIES

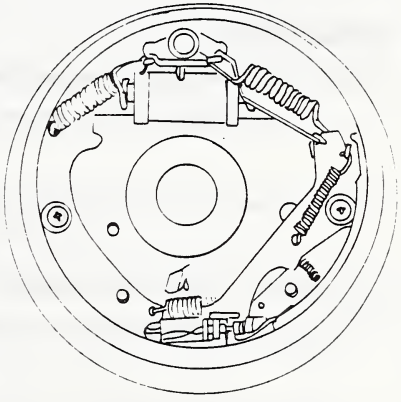
- Delco Morraine brake unit
- Jack stands (4)
- Floor jack
- Hold-down spring tool
- Return spring tool
- Standard blade screwdriver
- Brake spoon
- Service manual for brake unit
- Rags
- Safety glasses
- Protective clothing
- Backing plate lubricant

PROCEDURE

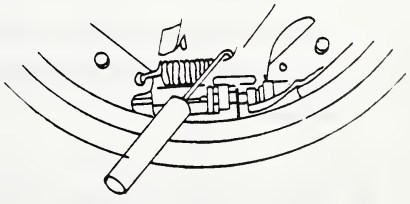
This operation can only be performed on operational vehicles by, or under supervision of, a certified motor mechanic.

A. REMOVAL

1. **Put on the safety glasses and protective clothing.**
2. **Support the car safely on jack stands.**
3. Remove all of the wheels.
   Note: Ensure that the emergency brake is off.
4. Push the adjuster lever away from the star wheel with the screwdriver and turn the star wheel with the brake spoon. Continue turning until the star wheel is at its shortest length.



5. Remove the brake drum (if the drum seizes ask your teacher/supervisor for assistance).
6. Clean the brake unit as directed by your teacher/supervisor.
7. Remove the primary shoe return spring.
8. Remove the secondary shoe return spring.
9. Remove the primary shoe hold-down spring assembly.



10. Pull the shoes apart at the top and remove the park brake link and spring.

11. Push the primary shoe in at the top and remove the adjuster spring, star wheel and primary shoe.

12. Remove the actuating link according to service manual instructions.

13. Remove the secondary shoe hold-down spring, adjuster lever assembly and lever return spring.

14. Unhook the emergency brake cable from the park brake lever, then remove the secondary shoe.

15. Remove the park brake lever from the secondary shoe if directed to do so by your teacher/supervisor.

16. Have your teacher/supervisor check your work.

B. **INSTALLATION**

Caution: If the brakes are not assembled correctly, the vehicle's braking action will be hampered. Your work must be 100% right to ensure vehicle safety.

1. Clean the parts, tools and your hands.

2. Lubricate ("lube") the backing plate pedestals as directed by your teacher/supervisor.
   Caution: Apply a minimum amount of the specialized, high temperature grease.

3. Install the park brake arm on the secondary shoe if it was removed.

4. Hook the emergency brake cable to the park brake lever.

5. Install the secondary shoe, adjuster lever assembly and hold-down spring assembly. (Make sure that the bottom hold-down washer is free to turn in both the secondary shoe and the adjuster lever.)

6. Install the primary shoe and hold-down spring assembly.

7. Spread the shoes apart and install the park brake link and spring.

8. Install the actuating link.

9. Install the secondary shoe return spring.

10. Install the primary shoe return spring.

11. Install the adjuster spring.

12. Pull both the shoes apart to install the star wheel adjuster.

13. Install the lever return spring.

14. **Have your teacher/supervisor check your work.**

15. Install the brake drum (adjust the brake if directed by your teacher/supervisor).

16. Install the wheel.

17. **Torque the lug nuts in the correct pattern.**

18. Clean and return all equipment, tools and supplies to their proper storage areas.

19. Clean up the work area.

20. Using the following chart as a guide, evaluate your performance.

	Excellent 4	Very Good 3	Good 2	Not Acceptable 1
The proper equipment, tools and supplies were selected.				
All steps in the procedure were completed.				
The shoes were installed in their proper position.				
The brake unit was assembled correctly.				
All related safety precautions were demonstrated.				
The equipment, tools and supplies were cleaned and returned to their proper storage areas.				
The work area was cleaned up.				

JOB SHEET 30
ADJUSTING REAR DRUM BRAKES

As the brake linings wear, the brake pedal must travel further to engage the brakes. This travel distance is called "free play" and normally should not exceed 25 mm. Rear brake adjustment is done to correct excessive free play.

EQUIPMENT, TOOLS AND SUPPLIES

- Shop vehicle with drum brake units
- Jack stands
- Floor jack
- Suitable brake spoon
- Narrow standard blade screwdriver or welding rod
- Trouble light
- Creeper
- Shop references
- Safety glasses
- Protective clothing

PROCEDURE

This operation can only be performed on operational vehicles by, or under the supervision of, a certified motor mechanic.

1. **Put on the safety glasses and protective clothing.**

2. Safely support the vehicle on the jack stands.
   Note: Ensure that the emergency brake is off.

3. Remove backing plate plugs.

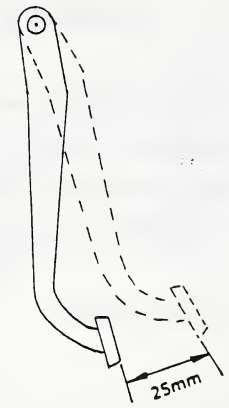
4. Look through the hole to determine the exact location of the adjuster arm and the star wheel.

5. Attempt to turn the star wheel in both directions. The way the star wheel will turn is the direction that tightens up the brake adjustment.

6. Tighten the star wheel until the wheel locks. The wheel cannot be turned either direction by hand.

7. Push the adjuster lever away from the star wheel.

8. Back the star wheel off the specified number of notches. (Usually about 9 is enough to give 25 mm of brake free play at the pedal.)



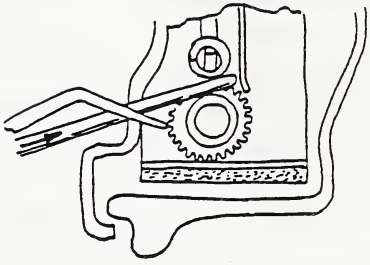
FREE PLAY

9. Adjust the remaining drum brake units.

10. Recheck the brake pedal free play and readjust brakes as required.

11. Install the backing plate plugs.

12. **Have your teacher/supervisor check your work.**



13. Install the wheels.

14. **Install and torque the lug nuts.**

15. Lower the vehicle.

16. Clean and return all equipment, tools and supplies to their proper storage areas.

17. Clean up the work area.

18. Using the following chart as a guide, evaluate your performance.

	Excellent 4	Very Good 3	Good 2	Not Acceptable 1
The proper equipment, tools and supplies were selected.				
All steps in the procedure were completed.				
The pedal free play was correct.				
All related safety precautions were demonstrated.				
The equipment, tools and supplies were cleaned and returned to their proper storage areas.				
The work area was cleaned up.				

JOB SHEET 31
BLEEDING THE BRAKE HYDRAULIC SYSTEM

For brakes to operate properly there must not be any air in the brake hydraulic system. The presence of air will result in a soft or "spongy" brake pedal action that hampers braking. Water and other contaminants may get into the brake fluid; therefore, the brake fluid should be "flushed" or changed every second year using the bleeding procedure.

EQUIPMENT, TOOLS AND SUPPLIES

- Shop vehicle
- Brake fluid
- Suitable bleeder wrench
- Fender covers (2)
- Bleeder hose and jar
  (with approximately 20 mm of used brake fluid)
- Standard blade screwdriver
- Rags
- Safety glasses
- Protective clothing

PROCEDURE

This operation can only be performed on operational vehicles by, or under the supervision of, a certified motor mechanic.

Caution: **Brake fluid will damage paint; therefore, fluids must immediately be washed off a vehicle's surface with soap and water.**

Note 1: If the vehicle has power brakes, check with your teacher/supervisor for additional directions.

Note 2: Work with a partner during this operation. Have your partner sit in the vehicle and pump the brake pedal according to your directions.

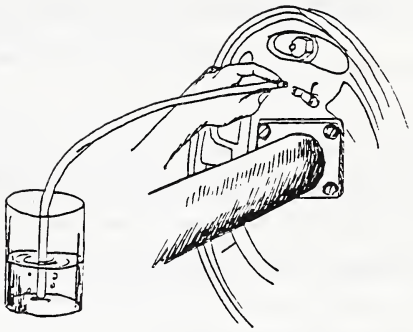
1. **Put on the safety glasses and protective clothing.**

2. Open the hood of the vehicle.

3. Put both fender covers in place.

4. Remove the reservoir cover from the master cylinder and top up the brake fluid. Reinstall cover.

5. Install the bleeder hose and wrench on the right rear bleeder screw. Place the end of the hose in a jar making sure it is submerged in brake fluid.



6. Have your partner pump up the brake pedal three times, removing partner's foot from the pedal the first two times. Hold the pedal down firmly on the third pump.

7. Open the bleeder screw enough to allow the old brake fluid to flow down the bleeder hose.

8. Close the bleeder screw as soon as fluid flow stops.

9. Have partner "pump up" the brake pedal again.

10. Continue to bleed brakes (Steps 7, 8 and 9) until all air bubbles and dirty fluid are gone. Check the fluid level in the reservoir frequently and top up the level as required.

11. Check the bleed screw tightness and move on to bleed the left rear, the right front and finally the left front bleeder screws.

12. **Check the brake pedal: if it feels spongy on application the bleeding operation must be continued.**

13. Install the reservoir cover properly.

14. **Have your teacher/supervisor check your work.**

15. Clean and return all equipment, tools and supplies to their proper storage areas.

16. Clean up the work area. (Dispose of old brake fluid in suitable disposal container.)

17. Using the following chart as a guide, evaluate your performance.

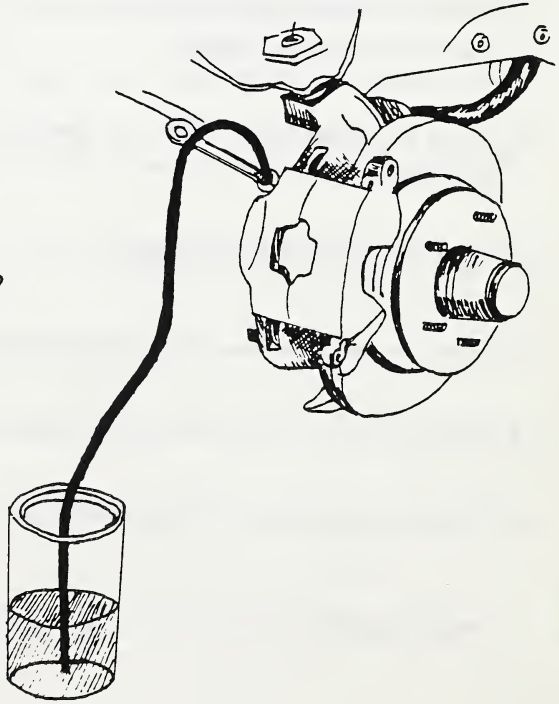
	Excellent 4	Very Good 3	Good 2	Not Acceptable 1
The proper equipment, tools and supplies were selected.				
All steps in the procedure were completed.				
The brake pedal was firm.				
The field reservoir was filled to the proper level.				
The brake fluid was clean.				
All related safety precautions were demonstrated.				
The equipment, tools and supplies were cleaned and returned to their proper storage areas.				
The work area was cleaned up.				

DISCUSSION TOPICS

1. How can air enter a brake hydraulic system?

2. How can water enter a brake hydraulic system?

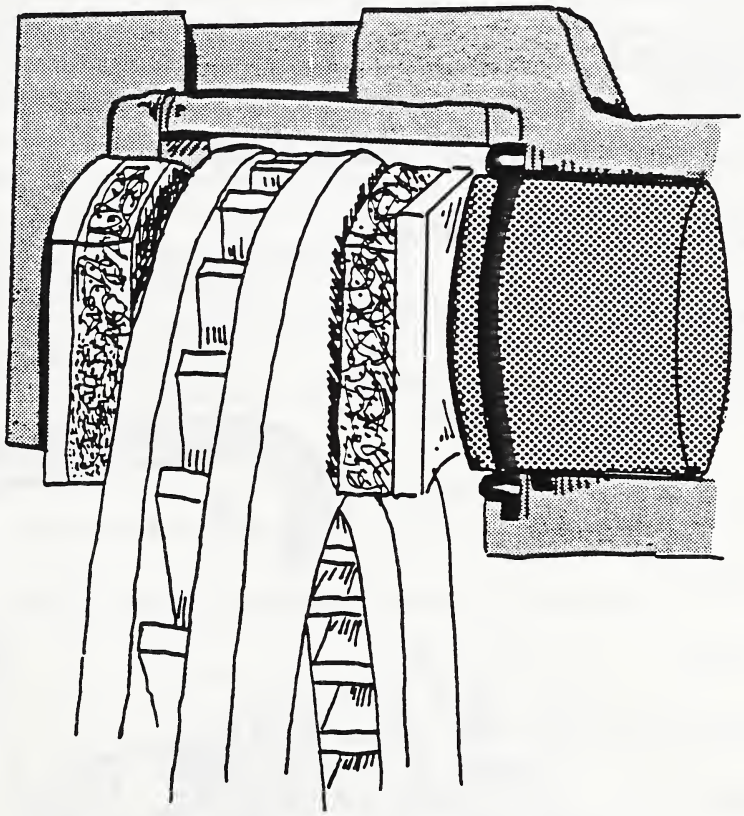
3. How can water affect a brake hydraulic system?



DISC BRAKES

All disc brake units are made of three main parts.

- Rotor – A spinning disc that attaches to the wheel.
- Caliper – A hydraulic "C" clamp.
- Pads – Two friction units that touch either side of the rotor.



Although the shape of parts and mounting hardware may vary, these three main parts are common to all disc brake units.

JOB SHEET 32
REMOVING AND REPLACING A SET OF DISC PADS

This job sheet only covers disc pad replacement on a practice brake unit. It does not cover other operations that are often required for front disc brakes. Your teacher/supervisor will discuss these other operations as required.

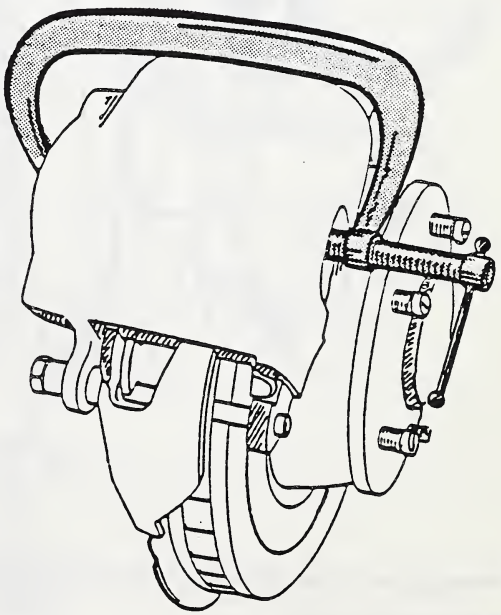
EQUIPMENT, TOOLS AND SUPPLIES

- Disc brake unit
- Suitable tools
- "C"clamp
- Safety glasses
- Protective clothing
- Shop references

PROCEDURE

This operation can only be performed on operational vehicles by, or under the supervision of, a certified motor mechanic.

1. Mount the brake unit securely as directed by your teacher/supervisor.
2. **Put on the safety glasses and protective clothing.**
3. Remove the caliper retaining hardware as indicated in the manual.
   Note: Hardware is the bolts, clips, slides and other parts that hold the caliper in place.
4. Compress the caliper piston with "C" clamp.
5. Remove the caliper.
6. Remove the pads.
7. Inspect the parts for wear or damage.
8. Install the pads.
9. Install the caliper.
10. Install the caliper hardware.



11. Clean and return all equipment, tools and supplies to their proper storage areas.

12. Clean up the work area.

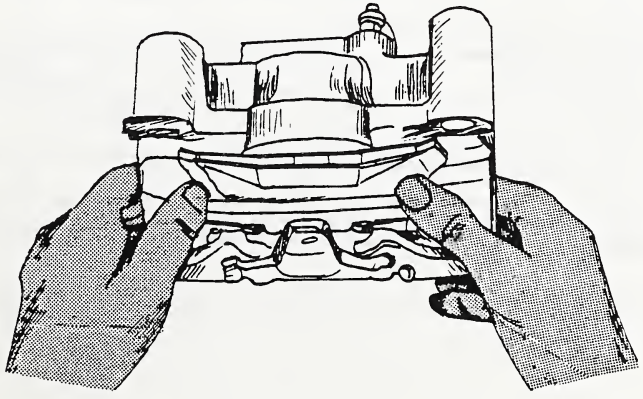
13. Using the following chart as a guide, evaluate your performance.

	Excellent 4	Very Good 3	Good 2	Not Acceptable 1
The proper equipment, tools and supplies were selected.				
All steps in the procedure were completed.				
The pads were installed in the proper position.				
The disc brake unit was reassembled correctly.				
All related safety precautions were demonstrated.				
The equipment, tools and supplies were cleaned and returned to their proper storage areas.				
The work area was cleaned up.				

DISCUSSION TOPICS

1. What other operations are usually performed when the disc pads are replaced?

2. What other problems should be watched for during disc pad replacement?



AUTOMOTIVE TESTING

The ability to diagnose what may be wrong with a vehicle is one of the most important skills in automotive services. Parts and labour are expensive, therefore the automotive mechanic must determine what is wrong before starting any repair work. The process of testing for non-working systems and parts is called TROUBLESHOOTING.

STUDENT ACTIVITIES

This activity is designed to give you a chance to observe basic diagnostic procedures for some common vehicle problems. To familiarize you with these procedures, the teacher/supervisor will demonstrate some basic troubleshooting techniques. Use the following chart to record the basic testing procedures observed.

Problem	Possible Cause	Testing Procedures
Vehicle won't turn over	a) Dead battery	
	b) Bad connections	
	c) Bad starter	
Vehicle turns over but will not start	a) No spark	
	b) No fuel	
	c) No compression	

Problem	Possible Cause	Testing Procedures
Lack of power	a) Lack of fuel	
	b) Lack of air	
	c) Timing chain	
Knocking sounds	a) Worn valve train	
	b) Worn bearings	
	c) Other engine knocks	
Squealing sounds	a) Alternator bearings	
	b) Fan belts	
Overheating	a) No coolant	
	b) No circulation of coolant	
Vibration	a) Ignition miss	
	b) Carburetor adjustment incorrect	

COMPRESSION TESTS

Compression tests are performed to check the condition of internal engine sealing parts (e.g., valves, piston rings). Compression refers to the air pressure that the engine develops in the cylinder. Compression pressures must be within manufacturer's specifications or the engine will not operate properly.

Too low a compression may result in:

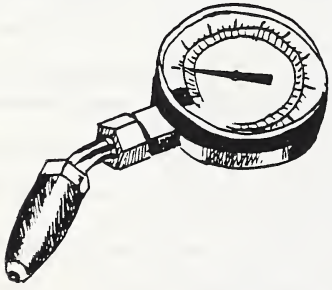
- lack of power
- rough running or misfiring
- inability of engine to run.

Too high a compression may result in:

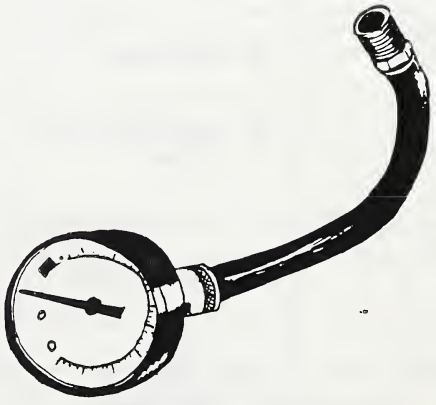
- detonation (damaging early ignition of air-fuel mixture)
- run-on (continued turning of the engine after the ignition switch is off).

Compression testers are tools used to measure air pressure in an engine's cylinders. Testers are classified according to how they are attached to the cylinder spark plug hole. There are two main types:

- push-in gauges with tapered rubber ends
- screw-in gauges with threaded adapters.



PUSH-IN STYLE



SCREW-IN STYLE

Compression readings are taken as the engine is turned over and the air in the cylinder moves the needle up the clocklike face of the gauge. Valves in the tester hold the needle at its highest position to allow easy reading.

Normal compression readings for a warm, modern engine are about 150 pounds per square inch (psi) when in peak condition.

Generally the highest and lowest readings should not vary by more than 20% from each other. This means that if the highest reading is 150 psi the maximum difference should be $150 \times .20 = 30$ psi. The lowest reading permissible would be $150 - 30 = 120$ psi. Repair manuals will list minimum standards for compression readings.

Normally, minimum pressure for a compression test is considered to be 100 psi. Maximum pressures are considered to be 160 psi on an unoiled cylinder. Remember to check your manual for specifications.

If the first compression test has low readings the mechanic may add oil to the cylinder and take a second compression test to diagnose the problem. The first set of readings is called the **DRY TEST** and the second set of readings is called the **WET TEST**.

The addition of oil seals piston rings but not valves. A set of "wet" readings should increase a small amount over the "dry" test readings (maximum 10%). Large increases indicate worn rings; little or no change indicates bent, worn, burnt or other valve problems.

Compare the following readings and the problems identified.

	Dry	Wet	Problem
Cylinder No. 1	90 psi	95 psi	Valve problem
Cylinder No. 2	110 psi	150 psi	Worn rings

Other possible problems that can be detected by using a compression test include:

- too high a "dry" reading can indicate carbon buildup
- equal readings for side by side cylinders can indicate a blown head gasket
- uniform low readings can indicate wear of the timing chain.

STUDENT ACTIVITIES

1. Calculate the lowest allowable compression reading for each high reading.

Example:	150 psi	150 × .2 = 30	150 − 30 = 120	120 psi

a. 130 psi _____

b. 145 psi _____

c. 140 psi _____

d. 135 psi _____

2. Define the term "compression". _____

_____

3. Discuss: "How does an engine's compression affect its performance?" Record the major points from the discussion.

_____

_____

_____

4. Diagnose possible problems from each of the following sets of readings (e.g., No. 3 cylinder has valve problems, engine OK).

a.

Cylinder No.	DRY	WET
1	150	155
2	130	135
3	140	145
4	145	145

DIAGNOSIS _____

b.

Cylinder No.	DRY	WET
1	150	155
2	90	91
3	145	145
4	135	140

DIAGNOSIS _____

c.

Cylinder No.	DRY	WET
1	100	145
2	100	140
3	105	155
4	100	155

DIAGNOSIS _____

JOB SHEET 33
TAKING A COMPRESSION TEST

EQUIPMENT, TOOLS AND SUPPLIES

- Compression tester
- Torque wrench
- Spark plug socket
- Ratchet
- Extension
- Fender covers (2)
- Oil can and oil
- Shop reference manual
- Safety glasses
- Protective clothing

PROCEDURE

Caution: To prevent electrical shock, the power to the ignition must be disconnected prior to taking a compression test.

Note 1: Work with another student on this task.

1. Put both fender covers in place.
2. **Put on the safety glasses and protective clothing.**
3. **Connect the exhaust pickup hose to the tailpipe.**
4. With your teacher's/supervisor's permission, start the vehicle and allow engine to warm up to operating temperature.
   Caution: Avoid contact with hot surfaces and moving parts during this task.
5. Look up the compression specifications in the manual and record them on the compression test record chart.
6. **Shut off the engine and disconnect the ignition coil power source.**
7. Remove the spark plug wires by holding and twisting the spark plug boot while gently pulling the boot off the spark plug.
   Note: If the wires are not numbered, tag each of them with the appropriate cylinder number as they are removed.
8. Remove the spark plugs.
9. Install the compression tester in the cylinder no. 1 spark plug hole.
10. Have your partner depress the gas pedal fully and continuously spin over the engine six times.
11. Record cylinder no. 1 "dry" reading on the compression test record chart.

12. Test and record the "dry" readings for the remaining cylinders.

13. Use an oilcan to squirt 25 mL of motor oil through the spark plug hole into each cylinder.

14. Have your partner spin the engine over for 15 seconds to distribute oil.

15. Take a "wet" reading for each cylinder and record your results.

16. Diagnose the readings so you can identify and record your answers.

17. Reinstall the spark plugs.
    Note: Tighten the spark plugs to the specified torque.

18. Reinstall the spark plug wires and remove any attached tags.

19. Reconnect the ignition coil power source.

20. Clean and return all equipment, tools and supplies to their proper storage areas.

21. Clean up the work area.

22. Using the following chart as a guide, evaluate your performance.

	Excellent 4	Very Good 3	Good 2	Not Acceptable 1
The proper equipment, tools and supplies were selected.				
All steps in the procedure were completed.				
The proper specifications were recorded.				
The spark plugs were reinstalled properly.				
The spark plug wires were reinstalled properly.				
The readings were accurate.				
The readings were diagnosed properly.				
All related safety precautions were demonstrated.				
The equipment, tools and supplies were cleaned and returned to their proper storage areas.				
The work area was cleaned up.				

COMPRESSION TEST RECORD CHART

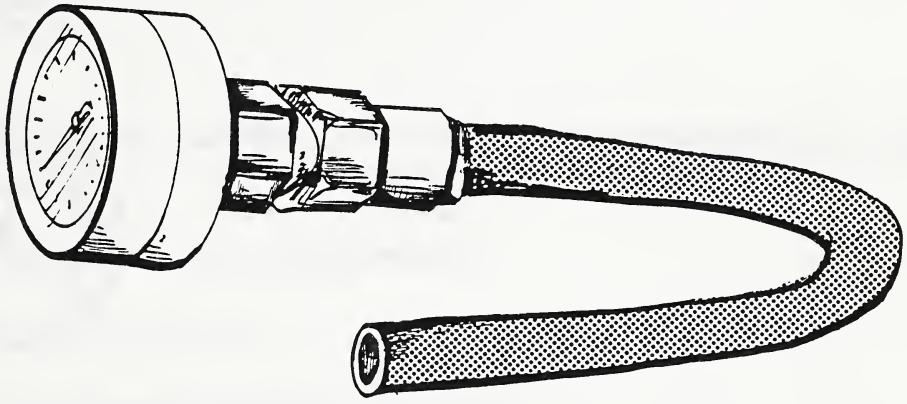
Specification _____ psi

Cylinder No.	Dry	Wet	Diagnosis
1			
2			
3			
4			
5			
6			
7			
8			

VACUUM TESTS

A vacuum gauge is used to test the vacuum in the air induction system of an automotive engine. The gauge hose is installed on the intake manifold's vacuum fitting.

Sufficient vacuum is necessary to ensure the engine's air-fuel mixture can be properly adjusted.

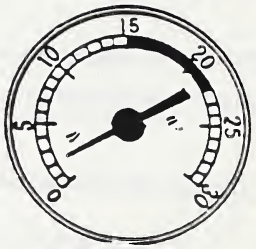


VACUUM GAUGE

Normally, an intake manifold vacuum is between 15 to 22 inches of mercury registered on a vacuum gauge's scale. Newer vehicles with many emission controls have lower vacuum readings. To find the specifications check the owner's manual or shop references for the year and model of your vehicle.

Many engine problems can be detected with the use of a vacuum gauge providing the readings are interpreted correctly. For example:

- Intake manifold vacuum leak – low, steady reading.



- Valve problem (sticking, burned, etc.) – close to normal reading with sharp down scale movements of about 3" or 4" of mercury.

- Clogged exhaust system – reading normal until the engine is accelerated then the needle will drop as pressure builds in exhaust.

- Improper carburetor adjustment – the needle sways back and forth.

JOB SHEET 34
PERFORMING A VACUUM TEST

EQUIPMENT, TOOLS AND SUPPLIES

- Vehicle
- Vehicle manual
- Shop manual for vehicle specifications
- Fender covers (2)
- Vacuum gauge
- Safety glasses
- Protective clothing

PROCEDURE

Caution: The engine must be running for this test. Avoid contact with moving parts and hot surfaces.

1. **Put on the safety glasses and protective clothing.**
2. Put both fender covers in place.
3. **Connect an exhaust gases pickup hose to the tailpipe.**
4. Remove a hose of similar size to the gauge hose from intake manifold at a spot that leads directly to the intake passageways.
5. Install the vacuum gauge hose on the open fitting.
   Note: Make certain that the hose does not touch hot or moving parts.
6. With your teacher's/supervisor's permission, start the engine and let it run to warm up.
7. Take a vacuum reading at operating temperature and normal curb idle speed. Record the reading as "A".
8. Take a vacuum reading at 2000 – 2200 RPM. Record the reading as "B".
9. Accelerate the engine several times and watch the vacuum gauge.
10. Shut off the engine.
11. Remove the vacuum gauge.
12. Reinstall the original hose on the intake manifold vacuum fitting.

13. Diagnose any problems and record your decision.

14. Clean and return all equipment, tools and supplies to their proper storage areas.

15. Clean up the work area.

16. Using the following chart as a guide, evaluate your performance.

	Excellent 4	Very Good 3	Good 2	Not Acceptable 1
The proper equipment, tools and supplies were selected.				
All steps in the procedure were completed.				
The proper test point was selected.				
The readings were accurate.				
The diagnosis was correct.				
All related safety precautions were demonstrated.				
The equipment, tools and supplies were cleaned and returned to their proper storage areas.				
The work area was cleaned up.				

VACUUM READING RECORD CHART

Readings	Diagnosis
A.	
B.	

COOLING SYSTEM PRESSURE TESTS

Before starting this section, review *Automotive Services 16 Student Workbook*: "Cooling Systems".

The cooling system is vital to the life and operation of the automotive engine. The system must maintain pressure to keep the coolant from boiling. Pressure may be lost due to:

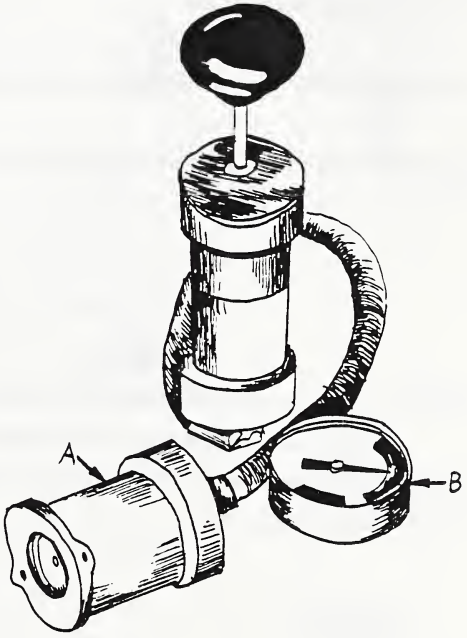
- a faulty radiator cap
- a coolant leak.

Cooling system pressure testers are used to check for both of these faults.

When working on cooling systems avoid:

- getting toxic coolant on any part of the body
- being burnt by hot engine parts.

A – RADIATOR CAP ADAPTER
B – PRESSURE TESTER

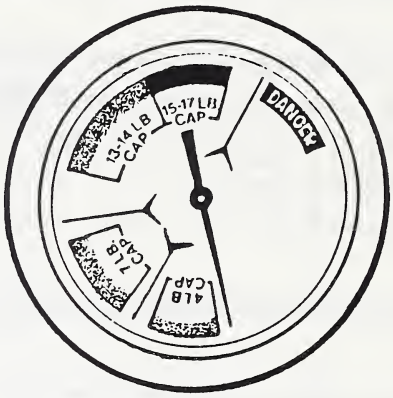


COOLING SYSTEM PRESSURE TESTER KIT

JOB SHEET 35
PRESSURE TESTING A COOLING SYSTEM

EQUIPMENT, TOOLS AND SUPPLIES

- Vehicle
- Fender covers (2)
- Safety glasses
- Protective clothing
- Vinyl gloves
- Pressure tester kit
- Rags



GAUGE FACE

PROCEDURE

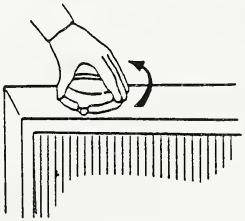
1. Put both fender covers in place.

2. **Put on your safety glasses, protective clothing and vinyl gloves.**

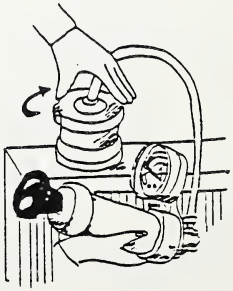
3. Squeeze the upper radiator hose to check for pressure.

Caution: Do not proceed until the engine has cooled enough to remove the radiator cap without any pressure in the system.

4. Remove the radiator cap by pressing down and turning counterclockwise.



5. Install the pressure tester on the radiator cap seat by pressing down and turning counterclockwise.

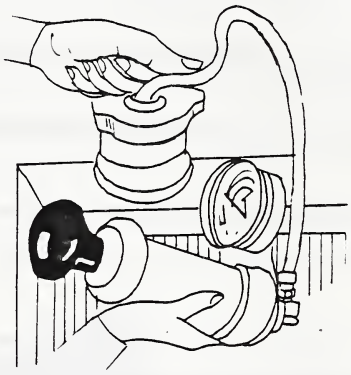


6. Check the pressure rating on the top of the radiator cap. Record the specification in the pressure testing results chart.

7. Pump the handle of the pressure tester to move the needle to the top of the bar in order to indicate the vehicle's pressure rating specification.

8. Observe the gauge needle. It should not drop for at least two minutes. Any movement indicates a leak in the cooling system.

9. Record your observations on the results chart.



10. Relieve the pressure on the tester.
    Note: This is usually done by tilting the hose at the radiator end of the tool.

11. Install the radiator cap adapter on tester by pressing down and turning clockwise.

12. Install the radiator cap onto the radiator cap adapter by pressing in and turning clockwise.

13. Pump the tester and record the maximum pressure at which the valve releases.

    Note: The reading should match specification on the cap.

14. Release the pressure and then remove the radiator cap from the adapter.

15. Reinstall the radiator cap on the radiator.

16. Clean and return all equipment, tools and supplies to their proper storage areas.

17. Clean up the work area.

18. Diagnose readings to identify problems.

19. Report all problems to the teacher/supervisor.

20. Using the following chart as a guide, evaluate your performance.

	Excellent 4	Very Good 3	Good 2	Not Acceptable 1
The proper equipment, tools and supplies were selected.				
All steps in the procedure were completed.				
The system was cool when the radiator cap was removed.				
The readings were accurate.				
All leaks were detected.				
The diagnosis was correct.				
All problems were reported.				
All related safety precautions were demonstrated.				
The equipment, tools and supplies were cleaned and returned to their proper storage areas.				
The work area was cleaned up.				

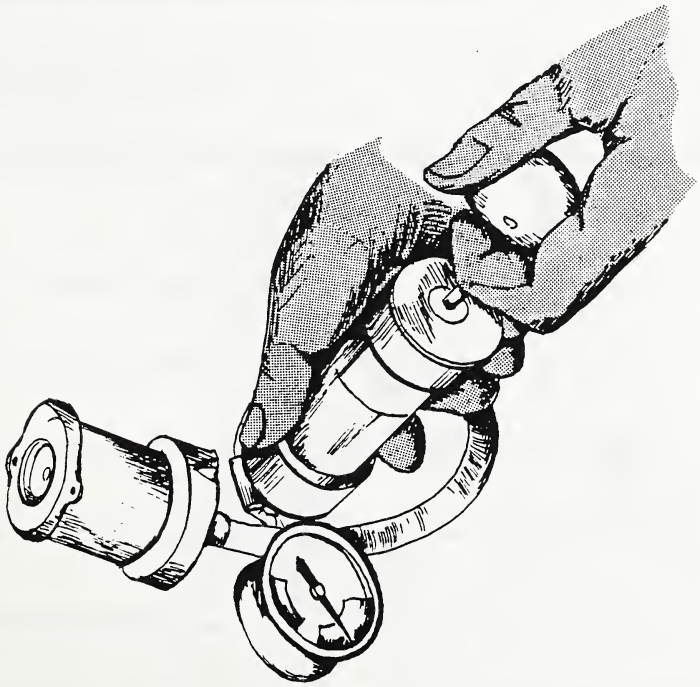
PRESSURE TESTING RESULTS CHART

- Radiator Cap Specification _____ psi
- Does the cooling system leak? _____
- Radiator cap release pressure _____psi
- What problems does this cooling system have?

  _____

  _____

  _____

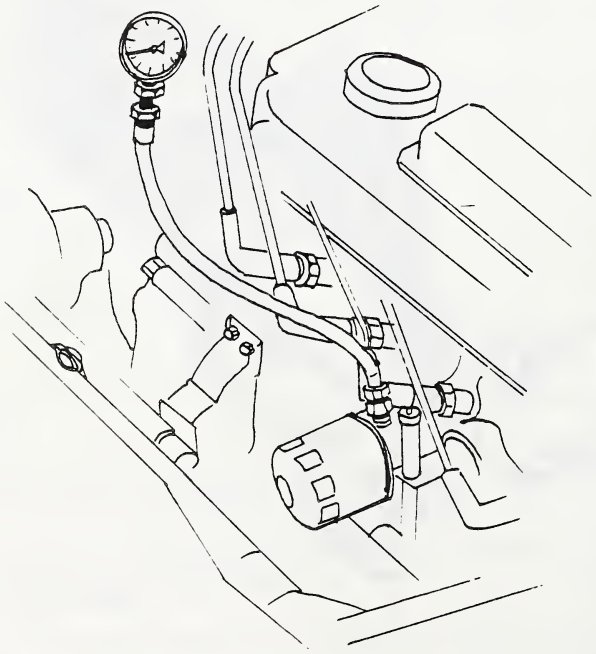


OIL PRESSURE TESTS

Motor oil is pumped throughout the engine to lubricate and cool parts. Without sufficient pressure not enough oil will get to the parts and damage can occur immediately. Pressure drop can be caused by wear of parts (bearings or oil pump), malfunction of parts (oil pressure relief valve), or lack of sufficient oil.

Oil pressure is tested by using an oil pressure gauge connected to the oil passages of a running engine. Care must be taken to avoid moving parts and hot items (including oil) during this test.

Maximum oil pressure is normally 60 psi. (Check the vehicle manual for exact specifications.)



JOB SHEET 36
PERFORMING AN OIL PRESSURE TEST

EQUIPMENT, TOOLS AND SUPPLIES

- Vehicle
- Shop references
- Safety glasses
- Protective clothing
- Tachometer
- Oil pressure gauge
- Suitable tools to remove sending unit
- Fender covers (2)
- Rags
- Teflon tape (if required)

PROCEDURE

Caution: Avoid touching moving parts, hot surfaces and hot oil.

1. **Put on the safety glasses and protective clothing.**

2. **Connect an exhaust gases pickup hose to the tailpipe.**

3. Put both fender covers in place.

4. Check and top up the oil level in engine if required. Record findings on oil pressure test results chart.

5. Have your teacher or supervisor identify the oil sending unit for you.

6. Remove the oil sending unit.

7. Install the oil pressure gauge hose fitting in the oil sending unit hole.

8. Check and record the oil pressure specifications from shop references.

9. Hook up the tachometer.

10. With your teacher's/supervisor's permission, start the engine and allow it to warm up.

11. Let the engine run at curb idle speed and record the oil pressure reading on the chart.

12. Run engine at the specified speed and record the oil pressure reading on the chart.

13. Shut off the engine.

14. Remove the oil pressure gauge hose and wipe the hose clean.

15. Reinstall the oil pressure sending unit, re-wrap the fitting threads with teflon tape if requested by your teacher/supervisor.

16. Clean and return all equipment, tools and supplies to their proper storage areas.

17. Clean up the work area.

18. Check the readings and indicate if they are within specifications.

19. Report all problems to your teacher/supervisor.

20. Using the following chart as a guide, evaluate your performance.

	Excellent 4	Very Good 3	Good 2	Not Acceptable 1
The proper equipment, tools and supplies were selected.				
All steps in the procedure were completed.				
The specifications were correctly identified.				
The readings were accurate.				
The diagnosis was correct.				
All related safety precautions were demonstrated.				
The equipment, tools and supplies were cleaned and returned to their proper storage areas.				
The work area was cleaned up.				

OIL PRESSURE TEST RESULTS CHART

- Was oil level correct? _____ How much oil was added? _____
- Specified Pressure _____ psi at _____ rpm
- Idle Pressure _____ psi at _____ rpm
- Test Pressure _____ psi at _____ rpm
- Was oil pressure within specifications? _____

COMMON REPLACEMENT SERVICES

The following tasks are frequently performed in the automotive service industry to maintain or repair vehicles. Some of these operations review work covered in Automotive Services 16; new operations are covered in more depth.

The following operations are included in this section:

- changing engine oil and oil filter
- replacing cooling system hoses
- replacing fan belts
- replacing automotive battery
- replacing automotive light bulbs
- replacing windshield wiper blades.

CHANGING ENGINE OIL AND OIL FILTER

Review this operation in the *Automotive Services 16 Student Workbook*, "Job Sheet 21".

STUDENT ACTIVITIES

1. Discuss and write answers to the following questions.

   - Why is engine oil changed?

     _____

   - Why is the oil filter changed at the same time?

     _____

   - How do you find out when to change the engine oil?

     _____

   - Where is the oil change sticker attached?

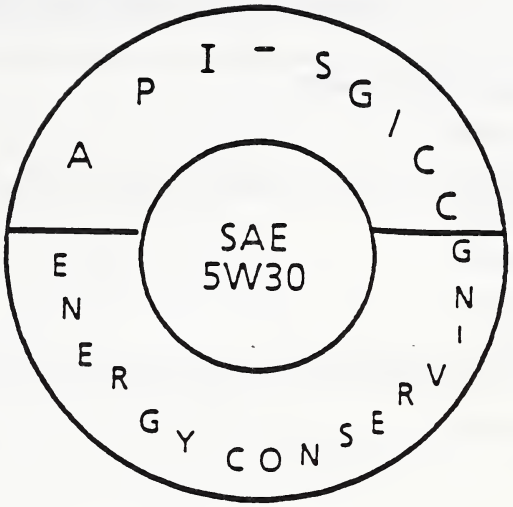
     _____

   - What safety precautions must be observed during oil changes?

     _____

     _____

2. Explain the following "doughnut".



API – _____

SG – _____

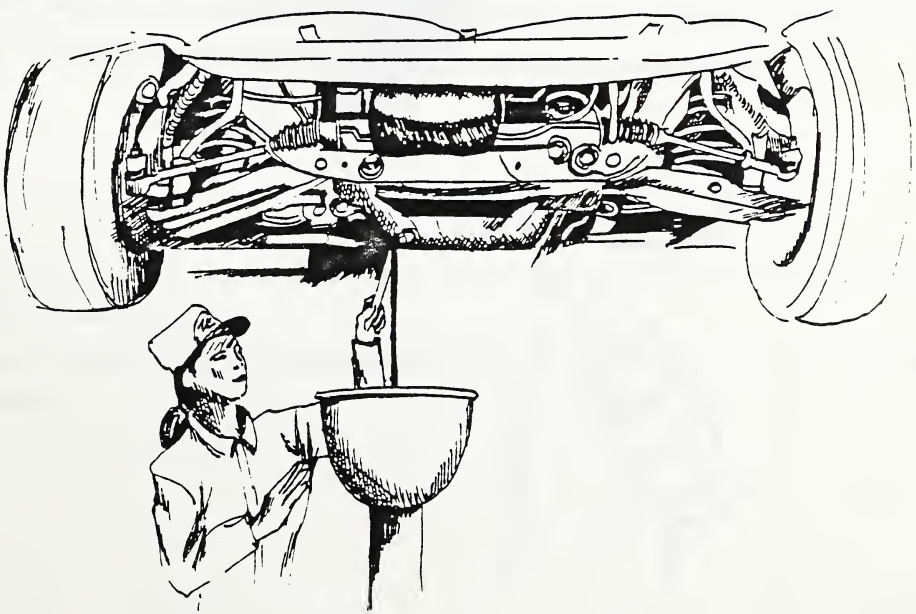
CD – _____

SAE – _____

5W30 – _____

ENERGY CONSERVING – _____

_____



JOB SHEET 37
CHANGING THE ENGINE OIL AND FILTER

EQUIPMENT, TOOLS AND SUPPLIES

- Vehicle on a hoist
- Oil drainmobile
- Wrench (to fit)
- Oil filter wrench
- Fender covers
- Oil filter chart
- Oil filter
- Oil change sticker
- Motor oil
- Safety glasses
- Protective clothing

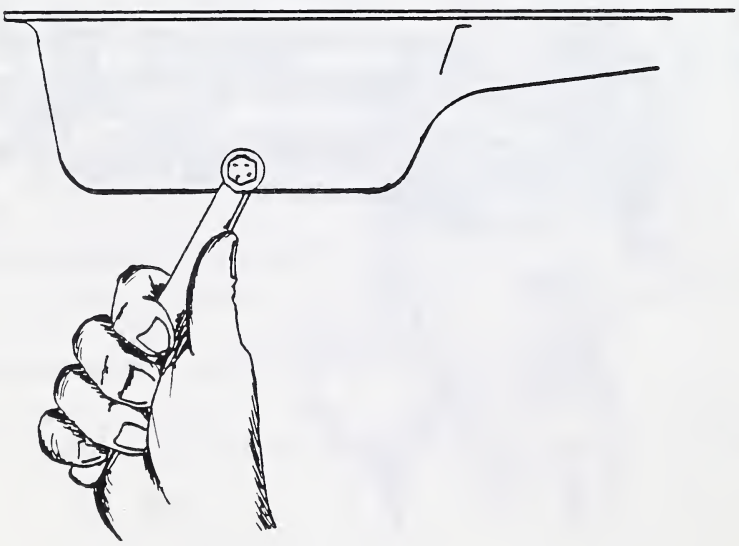
PROCEDURE

1. **Put on the safety glasses and protective clothing.**

2. Open the hood of the vehicle and place fender covers over the front fenders.

3. Raise the vehicle on the hoist and set the drainmobile under the oil pan.

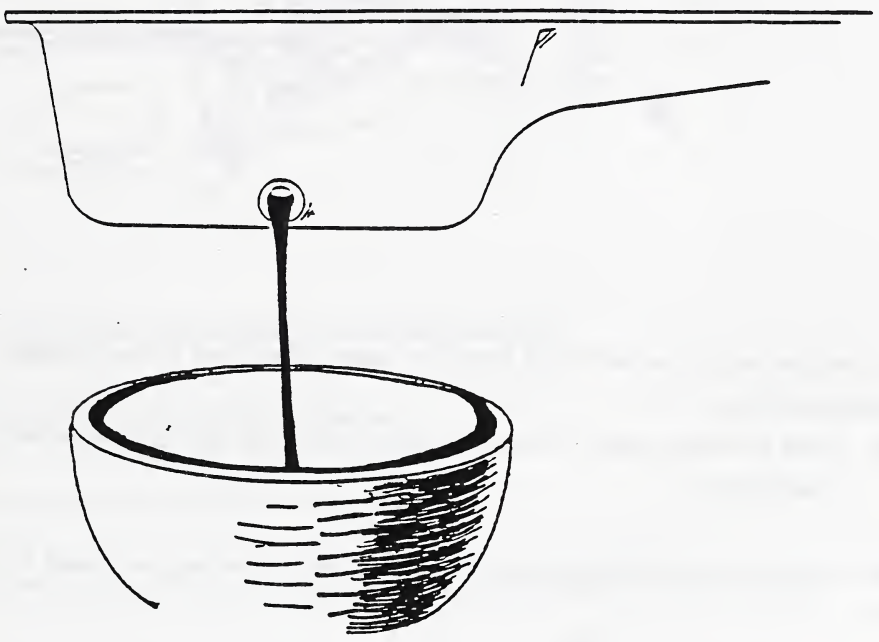
4. Using a 6-point box wrench, loosen the oil drain plug by pulling counterclockwise on the wrench.



5. Once the plug is loose, turn it the rest of the way by hand.

   Caution: **Be careful, the oil will come gushing out and it may be hot. Be prepared to catch the drain plug and move the drainmobile into the right spot.** Don't drop the drain plug into the drainmobile.

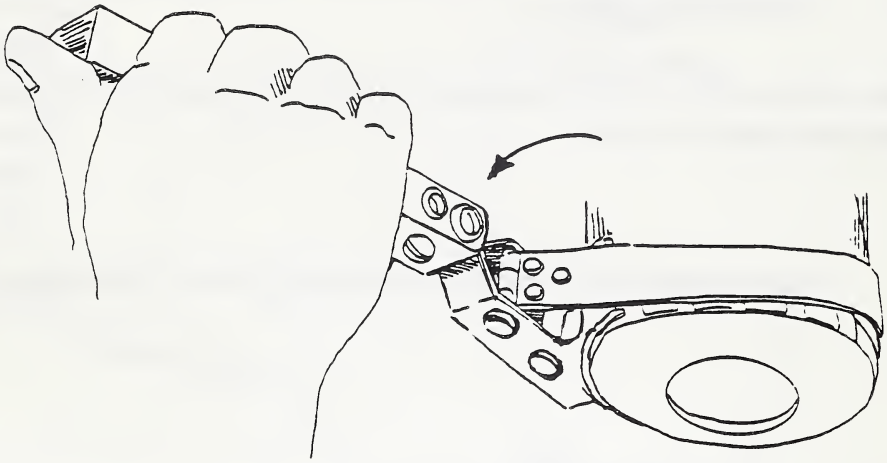
6. Allow the oil to run out. Check the washer on the drain plug to see that it is in good condition. Replace the washer if necessary.



7. Install the drain plug with the washer by hand. Turn it in at least three turns by hand before tightening it up with the wrench.

   Note: Do not overtighten the drain plug because the threads may strip and cause leaks or total oil loss.

8. Using the oil filter wrench, loosen the oil filter by turning it counterclockwise.

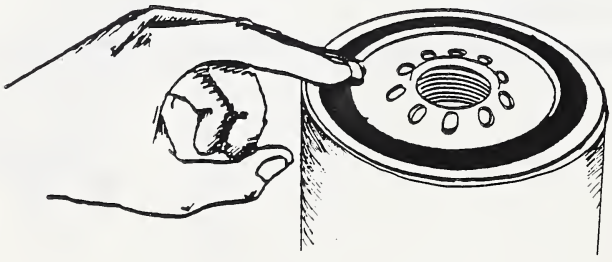


9. Place the drainmobile under the oil filter and, being careful not to burn yourself, carefully remove the oil filter.

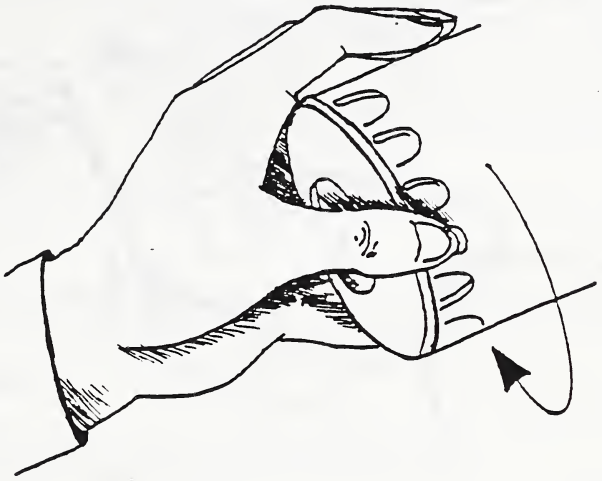
   Note: Some oil filters must be removed from the top of the vehicle rather than from underneath it.

10. Use the oil filter chart to find the correct oil filter for the vehicle's engine. Select the correct oil filter.

11. Spread a drop of clean motor oil over the rubber gasket on the new oil filter before installing it. The oil will prevent the new filter from sticking too tightly when it is removed.



12. Screw the new filter on by hand. Once it seals, tighten the filter by hand the recommended number of turns (1/2 to 1 1/2 turns).

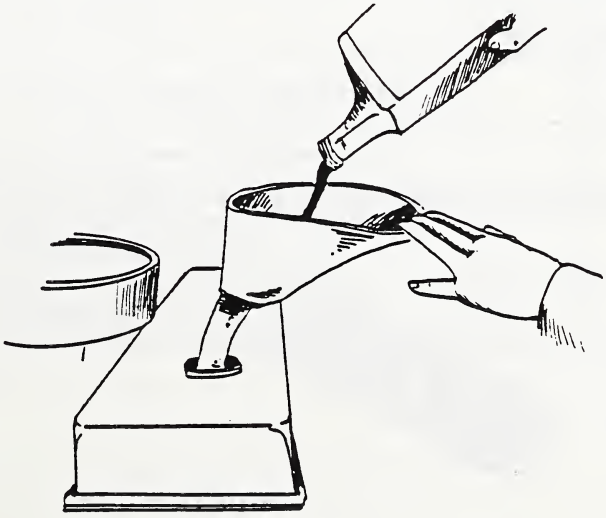


Note: Do not overtighten the filter or use a filter wrench.

13. Lower the vehicle. Remove the oil filter cap.

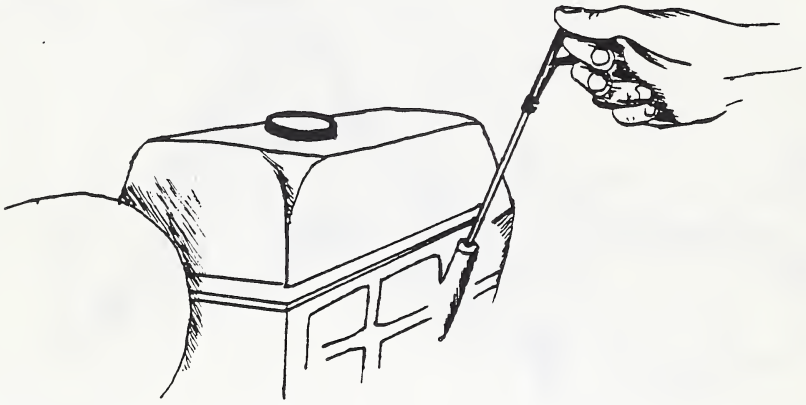
14. Place the oil funnel in the hole in the valve cover.

15. Pour the recommended amount of the appropriate, clean motor oil into the engine.



16. Wait two minutes for the oil to flow into the oil pan.

17. After the oil is in the engine, pull out the oil dipstick, wipe it dry and replace it. Pull it out again and check the oil level. It should read FULL. If not, add more oil and recheck until the level shows full.



18. Replace the dipstick.

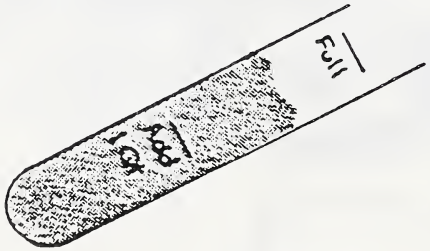
19. **Connect the exhaust gases pickup hose to the tailpipe.**

20. With the teacher's/supervisor's permission, start the engine.
    Note 1: Watch the oil pressure light. It should turn off in about five seconds after the engine is started.
    Note 2: If the light does not go out, shut the engine off immediately and check under the vehicle for an oil leak.

21. Check under the engine for leaks.

22. Shut off the engine.

23. Check the oil level again with the dipstick and, if necessary, top the oil up to the full line of the dipstick.



24. Fill out the engine oil change sticker according to the teacher's or supervisor's directions and stick it onto the door pillar as illustrated.

25. Clean and return all equipment, tools and supplies to their proper storage areas.

26. Clean up the work area.

27. Using the following chart as a guide, evaluate your performance.

	Excellent 4	Very Good 3	Good 2	Not Acceptable 1
The proper equipment, tools and supplies were selected.				
All steps in the procedure were completed.				
The engine oil level was correct.				
The oil filter was tight.				
The oil pan drain plug was tight.				
The oil change sticker was completed and applied properly.				
All related safety precautions were demonstrated.				
The equipment, tools and supplies were cleaned and returned to their proper storage areas.				
The work area was cleaned up.				

REPLACING COOLING SYSTEM HOSES

Review this operation in the *Automotive Services 16 Student Workbook.*

STUDENT ACTIVITIES

1. Answer the following questions.

   - What safety rules must be practiced when working with cooling systems?

     _____

     _____

     _____

   - From where is the coolant drained from the system?

     _____

   - What is the most common style of reusable hose clamp?

     _____

   - What equipment is used to test the antifreeze strength of the coolant?

     _____

JOB SHEET 38
REPLACING AN UPPER RADIATOR HOSE

EQUIPMENT, TOOLS AND SUPPLIES

- Vehicle
- Top radiator hose
- Tools as required
- Antifreeze drain pan
- Antifreeze tester
- Rag
- Funnel
- Fender covers (2)
- Safety glasses
- Protective clothing
- Wire brush

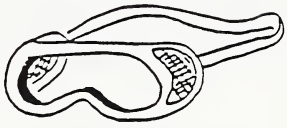
PROCEDURE

Caution: Avoid contact with coolant and antifreeze concentrate.

Note: This procedure can be used to replace other coolant hoses.

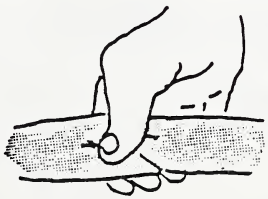
1. Open the hood and install a fender cover over each fender.

2. **Put on the safety glasses and protective clothing.**

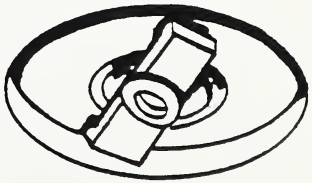


3. Check the cooling system for excess pressure and heat.

   Caution: Do not proceed until the system is cool and depressurized.

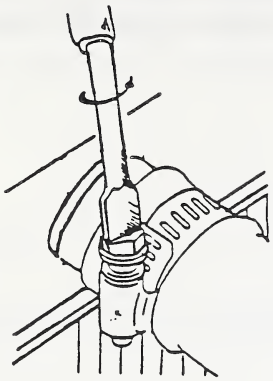


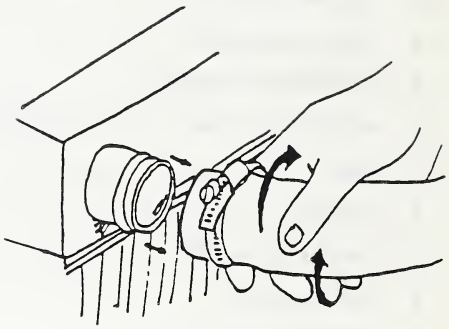
4. Locate the radiator drain plug.



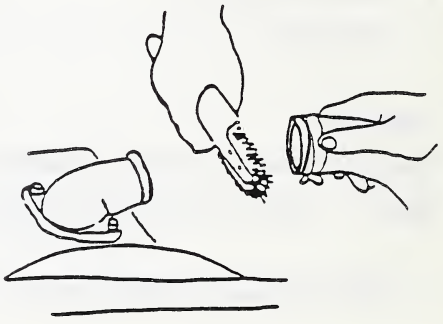
5. Drain the coolant into a pan by opening the radiator drain plug.

6. Loosen the top radiator hose clamps.

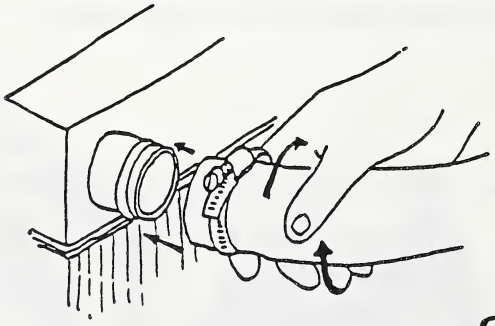




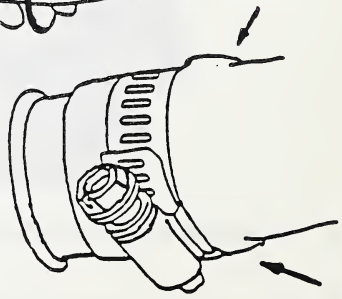
7. Gently twist the hose to break it free. If it sticks, slit the hose.



8. Clean the radiator inlet fitting and thermostat housing surface.



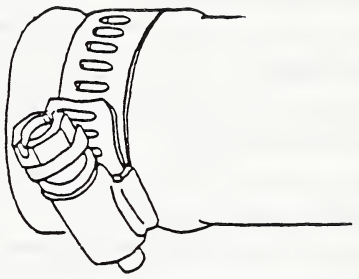
9. Remove the radiator hose clamp.



10. Install the clamps on the new hose.

11. Install the new hose correctly. Note the hose markings for proper flow direction.
    Note: Align the hose so it does not rub on any other parts.

12. Tighten the hose clamps until the rubber starts to bulge around the clamps.



13. Close the radiator drain plug.

14. Remove the radiator cap.

15. Using a funnel, pour in the coolant .

16. Check the coolant level and notify your teacher/supervisor if more coolant is required.
    Note: The coolant must also have the correct antifreeze strength.

17. With your teacher's/supervisor's permission, **install an exhaust gas pickup hose on the tailpipe,** start the engine and check for coolant leaks. Run the vehicle until the heater blows warm air.

18. Check the overflow tank to ensure proper coolant level.

19. Clean and return all equipment, tools and supplies to their proper storage areas.

20. Dispose of contaminated rags in an approved safety container.

21. Clean up the work area.

22. Using the followng chart as a guide, evaluate your performance.

	Excellent 4	Very Good 3	Good 2	Not Acceptable 1
The proper equipment, tools and supplies were selected.				
All steps in the procedure were completed.				
The cooling system was depressurized and cooled prior to draining.				
The hose was installed properly.				
The clamps are tight.				
The connections do not leak.				
The antifreeze strength is correct.				
The coolant level is correct.				
All related safety precautions were demonstrated.				
The equipment, tools and supplies were cleaned and returned to their proper storage areas.				
The work area was cleaned up.				

DISCUSSION TOPICS

1. Can one type of hose be changed for a different type of hose the same size?

2. Why is each radiator hose marked with an arrow?

3. a. If the heater will not blow hot air, what is the problem?

   b. How is this problem fixed?

REPLACING FAN BELTS

Review the operations in your *Automotive Services 16 Student Workbook*, "Job Sheets 19 and 20".

STUDENT ACTIVITIES

1. Answer the following questions.

   - Name the two types of fan belts commonly found on modern vehicles.

     _____ _____

   - Describe what to inspect for when checking fan belts.

     _____

     _____

   - Describe how to check fan belt tension.

     _____

     _____

   - Describe safety precautions required during a fan belt replacement.

     _____

     _____

JOB SHEET 39
REPLACING A FAN BELT

EQUIPMENT, TOOLS AND SUPPLIES

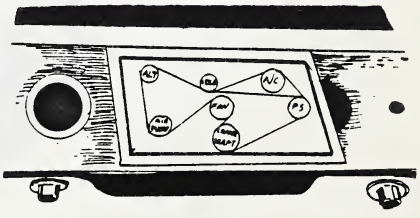
- Wrenches
- Socket set
- Pry bar
- Fan belt
- Safety glasses
- Protective clothing
- Fender covers
- Trouble light

PROCEDURE

Caution:

- **Some fan blades are sharp and can cause severe cuts.**
- **Take care not to pinch fingers under the belt during installation.**

1. **Put on the safety glasses and protective clothing.**
2. **Remove the key from the ignition switch to prevent anyone from starting the engine when you are working in the fan area.**
3. Raise the vehicle's hood.
4. Place the fender covers over the front fenders.
5. Inspect the belts for cracks, glazing or tears.
6. If any belt is in poor condition, re-inspect the rest of the belts.
   Note: A replacement of all belts may be required so that the customer does not have to come back in a few weeks to have another belt replaced.
7. Loosen the parts that need to be shifted.
8. Remove the belts, keeping them in order so that the new ones can be replaced in the same order.
9. Select the new belts, checking that they are the correct sizes.
10. Install the new belts in the right order over the pulleys.
11. Tension the belts as required.
    Note: Use a strand tension gauge or belt deflection test to determine belt tension.



12. Check the tightness of all fasteners.

13. Clean and return all equipment, tools and supplies to their proper storage areas.

14. Clean up the work area.

15. Using the following chart as a guide, evaluate your performance.

	Excellent 4	Very Good 3	Good 2	Not Acceptable 1
The proper equipment, tools and supplies were selected.				
All steps in the procedure were completed.				
All belt problems were reported.				
The belts were properly installed.				
Belt tension was properly tested.				
Belt tension is correct.				
All related fasteners are properly tightened.				
All related safety precautions were demonstrated.				
The equipment, tools and supplies were cleaned and returned to their proper storage areas.				
The work area was cleaned up.				

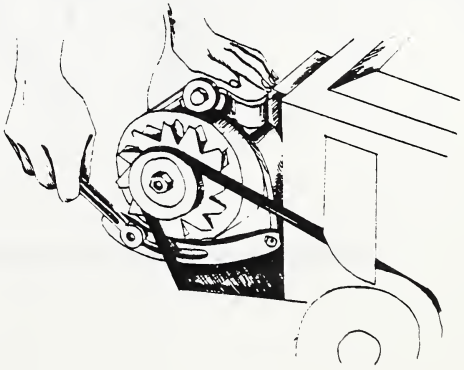
DISCUSSION TOPICS

1. What causes belts to wear?

2. What problems can loose belts cause?

3. What problems can excessively tight belts cause?

4. Why are some belt tensioners spring loaded?



REPLACING AUTOMOTIVE BATTERIES

The battery is the electrical power source for the entire vehicle. All automotive batteries will eventually "wear out" or suffer damage that will require replacement.

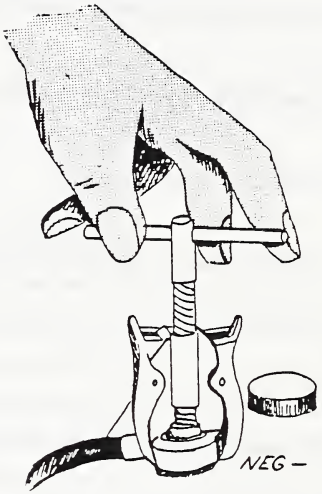
Because of the hazardous nature of battery work, the following safety rules must be observed:

- **safety glasses and vinyl gloves must be worn to protect you from battery acid burns**
- **disconnect the negative terminal of the battery first to prevent sparks that can ignite explosive gases.**

JOB SHEET 40
REPLACING A BATTERY

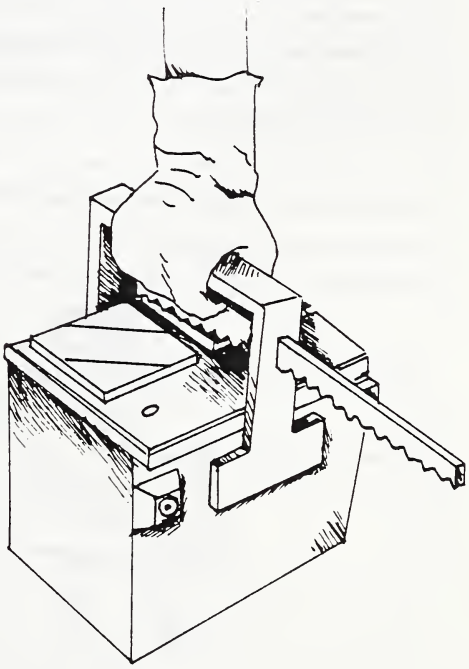
EQUIPMENT, TOOLS AND SUPPLIES

- Vehicle
- Replacement battery
- Battery post/terminal brush
- Tools as required
- Fender covers (2)
- Safety glasses or goggles or face shield
- Protective clothing
- Vinyl gloves
- Battery connection sealant spray



PROCEDURE

1. Open the hood and cover each fender with a fender cover.
2. **Put on eye protection, protective clothing and gloves.**
3. Disconnect the negative battery cable clamp from the battery terminal.
4. Disconnect the positive battery cable clamp from the battery terminal.
5. Remove the battery hold-down.
6. Note the position of the positive battery terminal.
7. Lift out the battery by hand or with a suitable lifting device.



8. Install the new battery with the positive terminal in the same position as the old battery.

9. Install the battery hold-down.

10. Clean and install positive and then negative battery cable clamps.

11. Spray the cable connection with battery connection sealant spray.

12. Clean and return all equipment, tools and supplies to their proper storage areas.

13. Clean up the work area.

14. Using the following chart as a guide, evaluate your performance.

	Excellent 4	Very Good 3	Good 2	Not Acceptable 1
The proper equipment, tools and supplies were selected.				
All steps in the procedure were completed.				
The cables were disconnected without damage.				
The battery was secure.				
The cables were properly reinstalled.				
All related safety precautions were demonstrated.				
The equipment, tools and supplies were cleaned and returned to their proper storage areas.				
The work area was cleaned up.				

REPLACING HEADLIGHTS

Vehicles require headlights for lighting the road and visibility to drivers in other vehicles. Many modern vehicles use headlights as daytime running lights.

STUDENT ACTIVITIES

1. Brainstorm the following questions:

   - What four headlight arrangements are commonly found on vehicles?

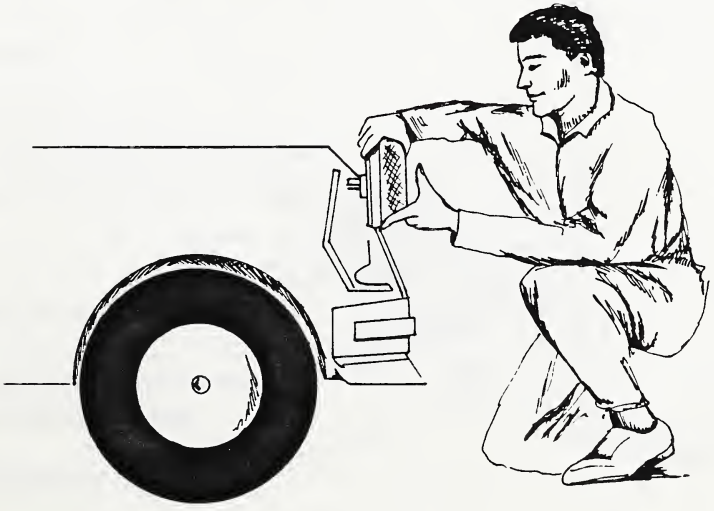
     _____
     _____
     _____
     _____

   - What shapes and sizes do headlights come in?

     _____
     _____
     _____
     _____

   - List two reasons why headlights may require replacement.

     _____ _____



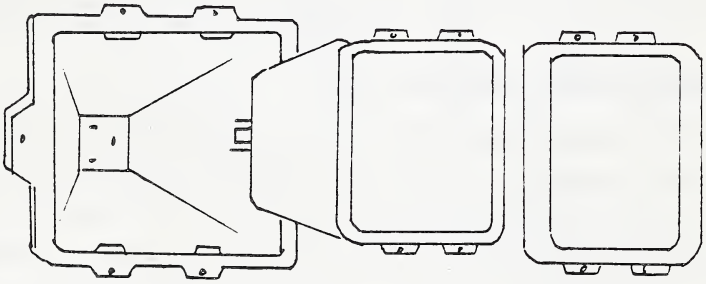
JOB SHEET 41
REPLACING A HEADLIGHT

EQUIPMENT, TOOLS AND SUPPLIES

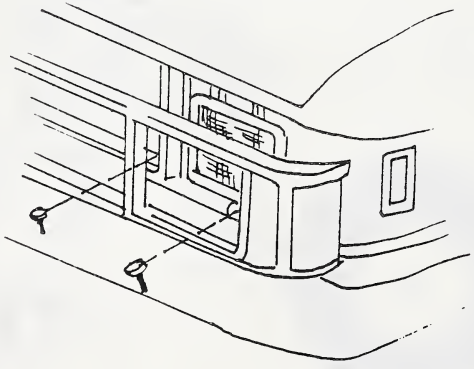
- Vehicle
- Tools as required
- Suitable headlight bulb

PROCEDURE

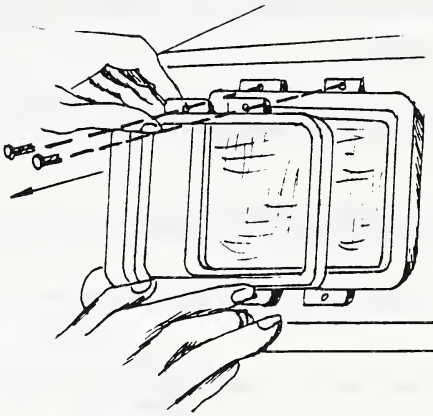
Note: There are many ways to mount a headlight bulb. This job sheet refers to the replacement of the common sealed beam bulb. Different vehicles may require different ways of accessing the headlight for replacement.



1. Turn on the headlights to determine which bulb is not functioning.

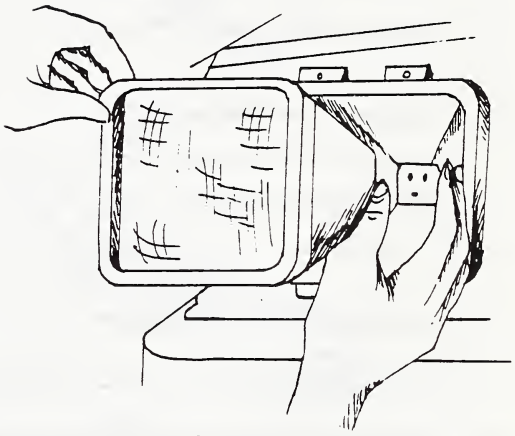


2. Remove the headlight trim.



3. Remove the headlight bezel screws and bezel.

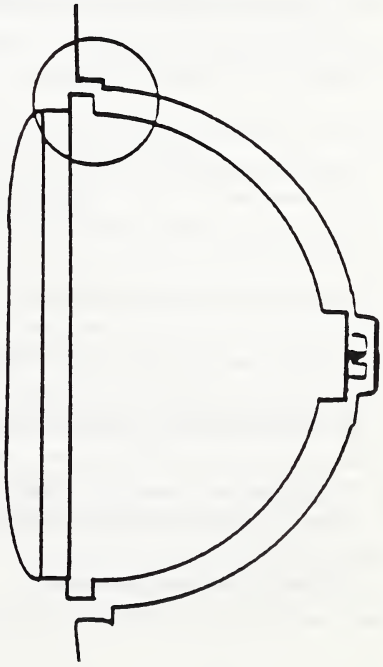
   Note: Headlight bulbs are positioned in a headlight 'bucket', and clamped in with the use of a bezel or retaining ring which must be removed to release the bulb.



4. Hold the headlight and carefully pull off the connector by grasping the plastic connector and wiggling the connection loose. DO NOT pull on wiring.

5. Examine headlight for:

   - cracks (visible inspection)
   - broken filaments (shake bulb and listen)
   - burned element (smoke stains on glass).



6. Examine connector for:

   - loose connections (wiggle wires)
   - broken wires (wiggle wires).

7. Install the connector on the new bulb.

8. Position the bulb in the headlight bucket, making sure the rear glass pedestals sit in the bucket indents.

9. Reinstall the headlight bezel.

10. Reinstall the headlight trim.

11. Check that the headlight bulb works.

12. Clean and return all equipment, tools and supplies to their proper storage areas.

13. Clean up the work area.

14. Record your observations.

Bulb Problem Conditions

_____

Connector Problem Conditions

_____

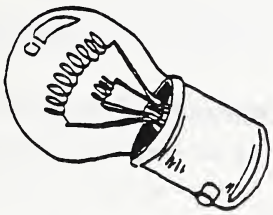
15. Using the following chart as a guide, evaluate your performance.

	Excellent 4	Very Good 3	Good 2	Not Acceptable 1
The proper equipment, tools and supplies were selected.				
All steps in the procedure were completed.				
Headlight was properly seated and secured.				
Headlight aiming was not disturbed.				
All related safety precautions were demonstrated.				
The equipment, tools and supplies were cleaned and returned to their proper storage areas.				
The work area was cleaned up.				

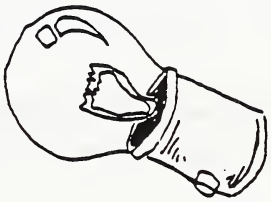
REPLACING LIGHT BULBS

Lights are essential to the safe operation of the vehicle. They also provide convenience lighting on demand.

There are four common styles of bulbs available. To identify a bulb, check the base and read the number that is marked on it.

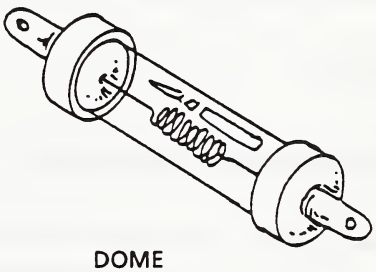


TAIL, STOP, DIRECTIONAL



BACKUP

MARKER



DOME

To remove tail, stop, directional or backup light bulbs, press in and turn the bulb slightly, counterclockwise, to release it.

To remove most marker and dome light bulbs, pull straight out of the socket.

All bulbs can be inspected by:

- turning on the light switch and checking that the bulb lights up
- removing the cooled bulb and checking for broken filaments, excessive smoke discolouration on the inside of the glass and corroded or damaged base contacts.

JOB SHEET 42
REPLACING A SIGNAL LIGHT BULB

This job sheet can be used as a guide to replace other light bulbs on vehicles.

EQUIPMENT, TOOLS AND SUPPLIES

- Vehicle
- New bulbs

PROCEDURE

Note: This job sheet is designed for modern vehicles with easily removable light sockets in the tail light housing. Other vehicles will require the removal of the tail light lens to perform this repair.

1. Have a classmate test the lights while you note which light bulbs are not working.

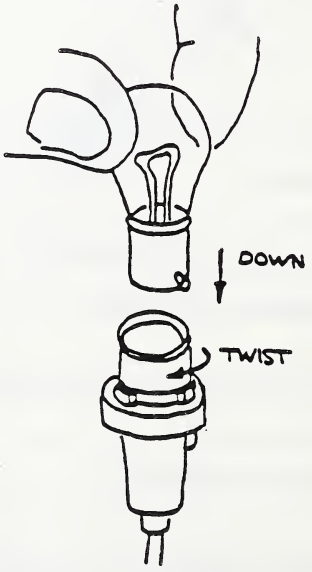
2. Open the trunk.

3. Identify the correct bulb socket to remove.

4. Grasp the socket, release any lock clip if equipped, and turn the socket counterclockwise a partial turn to release it.

5. Hold the socket in one hand and turn the bulb counterclockwise (about 1/8 of a turn) to release the bulb. If the bulb is seized, request assistance.

   Caution: **Do not use excessive force to squeeze or turn the bulb or it may shatter in your hand.**



6. Inspect the bulb. The glass should be clear and the element should be intact. The lead contacts and metal base should be corrosion free and clean. (Some newer vehicles use a special grease to protect the light assembly.)

7. Inspect the socket. The contact surfaces should be clean and corrosion free. The wiring connections and insulation should be undamaged.

8. Clean the socket as required.

9. Reinstall the bulb.

10. Reinstall the socket.

11. Close the trunk.

12. Clean and return all equipment, tools and supplies to their proper storage areas.

13. Record your findings.

Bulb condition report –

_____

Socket condition report –

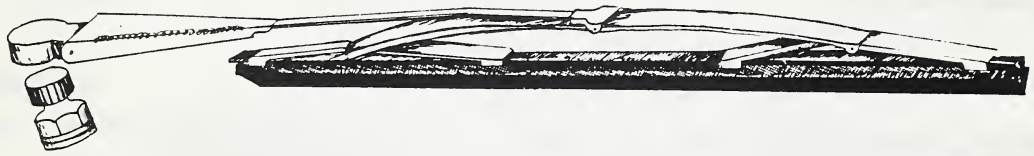
_____

14. Using the following chart as a guide, evaluate your performance.

	Excellent 4	Very Good 3	Good 2	Not Acceptable 1
The proper equipment, tools and supplies were selected.				
All steps in the procedure were completed.				
All burned out lights were noted.				
The bulb was properly installed.				
All related safety precautions were demonstrated.				
The equipment, tools and supplies were cleaned and returned to their proper storage areas.				
The work area was cleaned up.				

REPLACING WINDSHIELD WIPER BLADES

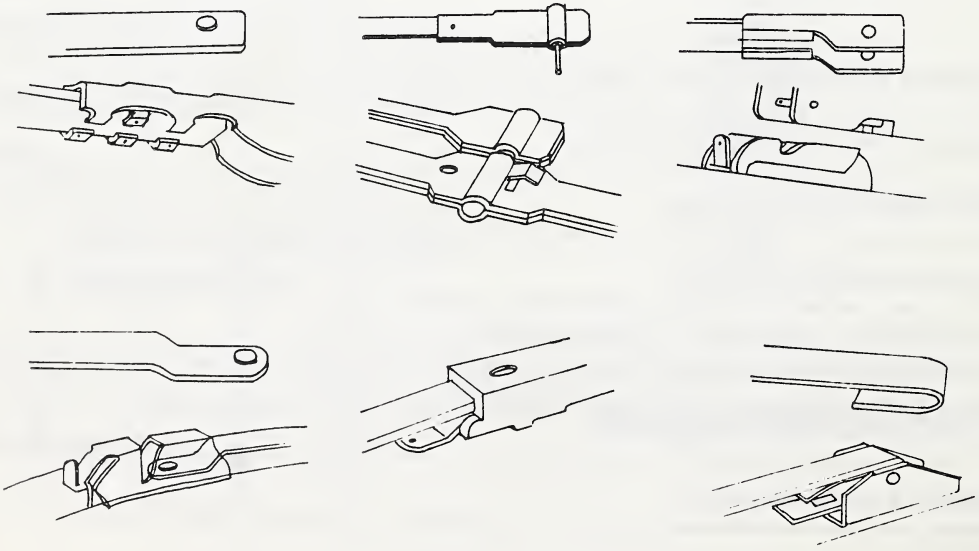
Windshield wipers maintain clear vision for the driver during rainstorms and other wet driving conditions. They are also used to aid in clearing ice and snow from the windshield even though they are not designed for this use.



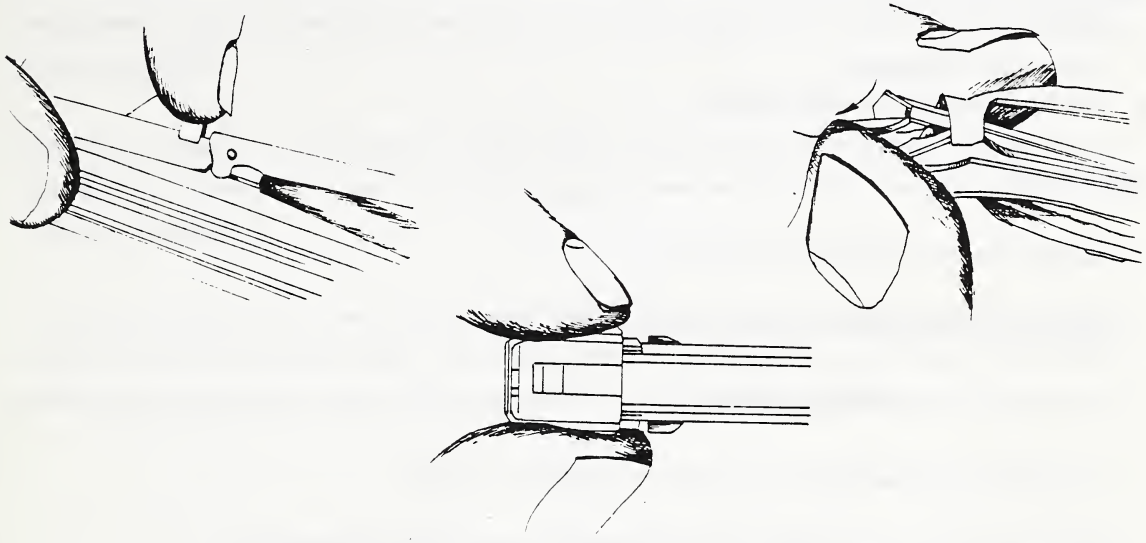
The wiper blades clear the water and other items from the glass. For this reason, the condition of the rubber is critical to proper wiper blade operation. Depending on the amount of use and conditions, most blades are expected to only last about twelve to twenty-four months. After this time, streaking or smearing can start to occur and obstruct the driver's view.

You may be able to replace only the blades or, depending on the vehicle design and parts supplier's stock you may have to replace the assembly. In both cases, the assembly must be removed from the arm before replacement.

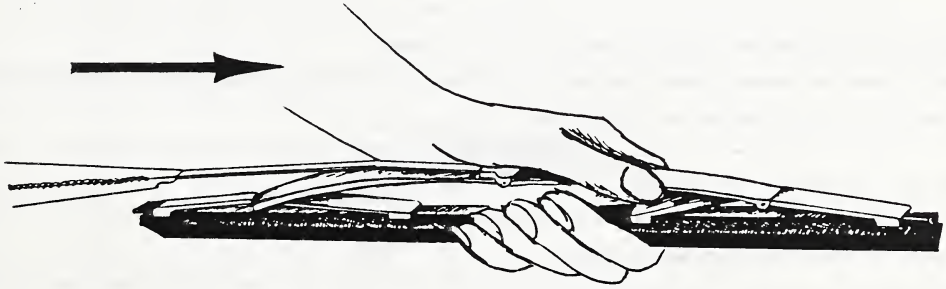
The following illustrations show how to remove common designs of blade assemblies.



After the assembly is removed, you will have to take out the old blade if a blade replacement is necessary. The following illustrations show how to remove the blade from the assembly frame.



Before completing the job, always give a slight tug on the blade assembly to make sure it is securely locked to the arm.



JOB SHEET 43
REPLACING WINDSHIELD WIPER BLADES

EQUIPMENT, TOOLS AND SUPPLIES

- Vehicle
- Screwdriver (if required)
- Replacement blade or blade assembly

PROCEDURE

1. Remove the blade assembly from the arm.

2. Replace the blade from the assembly frame if removable.

3. Install the blade assembly on the arm.

4. Tug on the wiper assembly to ensure that it is locked to the arm.

5. Clean and return all equipment, tools and supplies to their proper storage areas.

6. Clean up the work area.

7. Using the following chart as a guide, evaluate your performance.

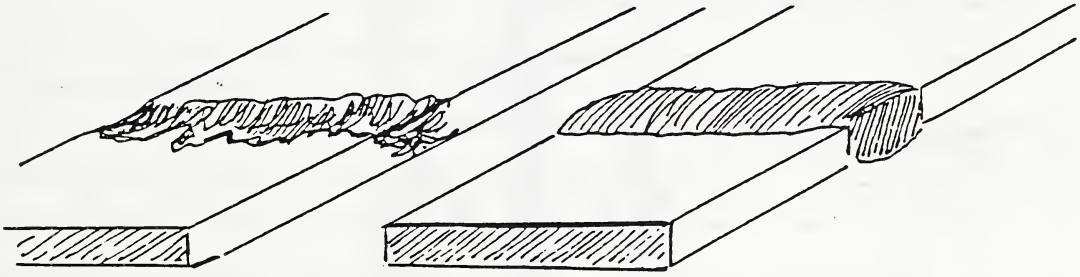
	Excellent 4	Very Good 3	Good 2	Not Acceptable 1
The proper equipment, tools and supplies were selected.				
All steps in the procedure were completed.				
The wiper assembly was secure.				
The wiper blade was installed properly.				
All related safety precautions were demonstrated.				
The equipment, tools and supplies were cleaned and returned to their proper storage areas.				
The work area was cleaned up.				

WELDING

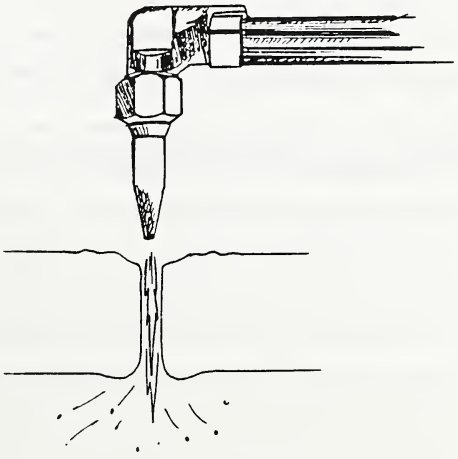
In a number of trades including agricultural mechanics, welding may be used to build or repair equipment. Automotive service workers often use welding equipment to perform heating, joining and cutting tasks.

Welding uses heat to join two pieces of metal. There are several types of welding. This section will describe the methods and equipment used for **oxyacetylene welding**. This type of welding is also called **gas welding**.

Gas welded joints can be either **fusion** or **non-fusion** welds. Fusion means joining. Fusion welding requires melting of the metal edges. The molten metal flows together to form a bond. Non-fusion welding uses a metal with a lower melting temperature to 'glue' parts together.



The equipment used for gas welding can also be used to cut metal. This is known as **oxyacetylene cutting**.



STUDENT ACTIVITIES

1. Using the following questions as a guide, interview an automotive mechanic who uses gas welding equipment.

   - What type of welding tasks do you perform in repair shops?

     _____
     _____
     _____

   - What equipment do you use for welding?

     _____
     _____
     _____

   - Where is welding done, indoors or outdoors?

     _____

   - What type of training is needed to be an efficient welder?

     _____
     _____

   - What are the advantages of welding over the use of nuts and bolts?

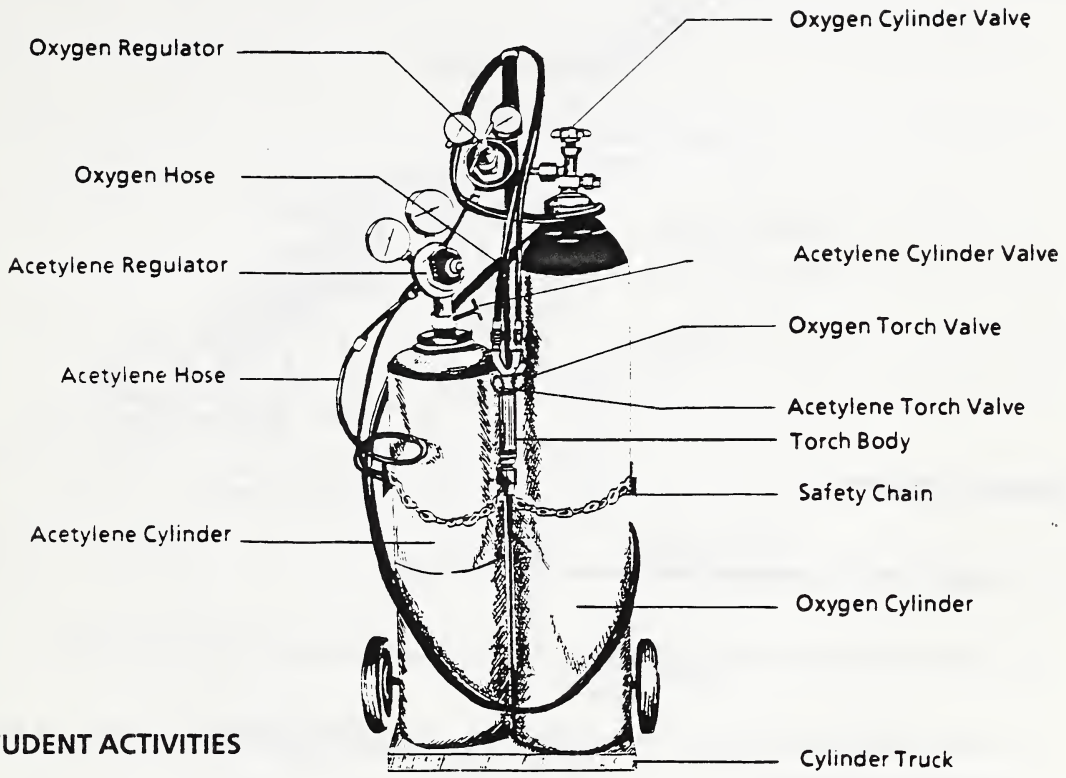
     _____
     _____
     _____

   - What are the disadvantages of welding over the use of nuts and bolts?

     _____
     _____
     _____

OXYACETYLENE WELDING EQUIPMENT

An oxyacetylene welding unit includes the following parts.



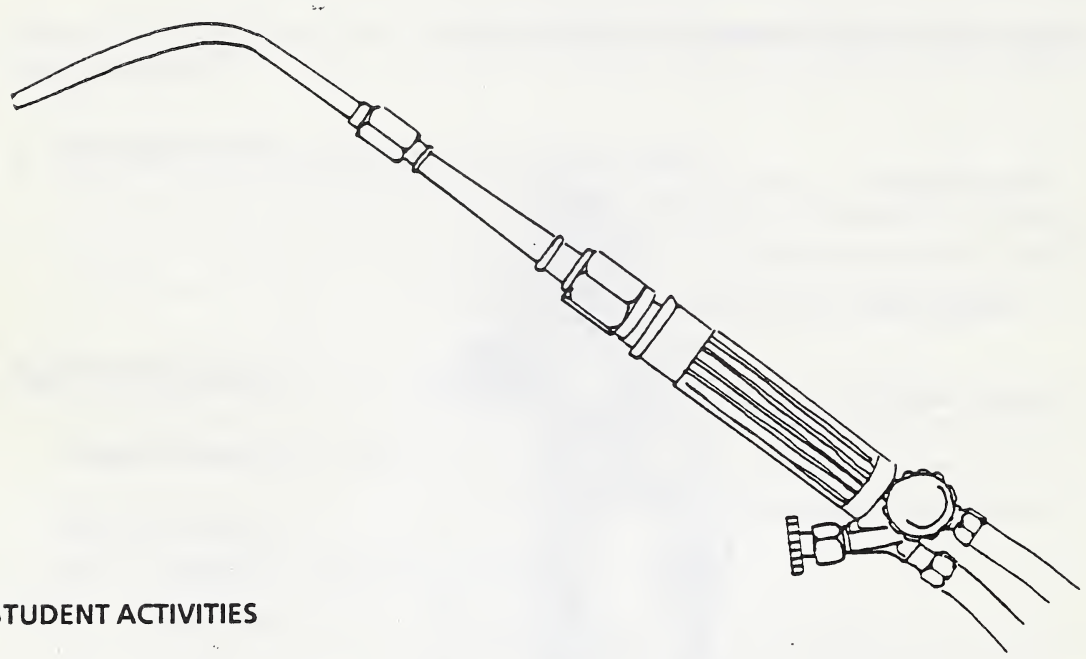
STUDENT ACTIVITIES

1. a. Inspect an oxyacetylene welding unit and note the colour of the hoses.

   b. Colour the hoses on the oxyacetylene welding equipment diagram above to match their actual colours.

2. Brainstorm: "Why do the hoses have different threads on each of the fittings?"

WELDING TORCH



STUDENT ACTIVITIES

1. a. Inspect a welding torch and note the colour of the hoses.

   b. Colour in the hoses on the welding torch diagram above to indicate their actual colour.

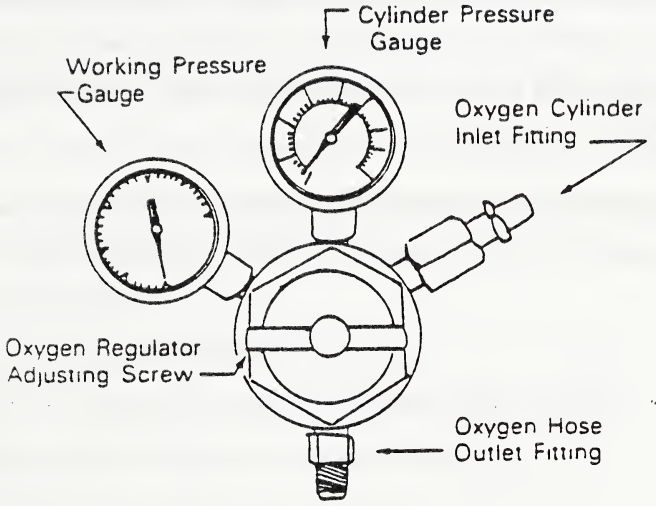
   c. Indicate the hose attachment thread direction as being either RH (right hand) or LH (left hand) on the diagram.

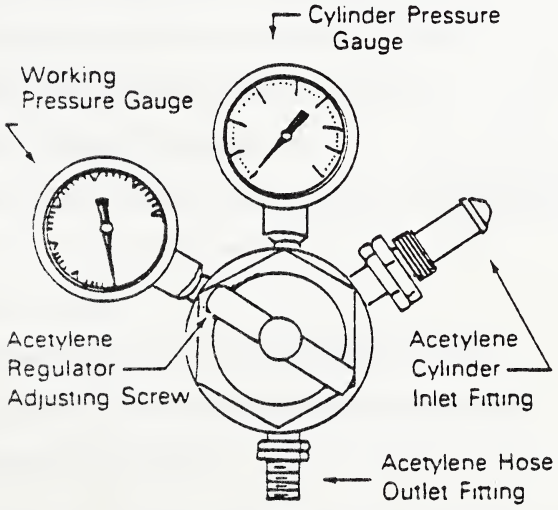
2. a. Examine several welding tips and compare the size of the orifice (hole) where the flame burns to the code stamped on the tip.

   b. Take inventory of all of the size codes available in the school lab or workplace. List them and indicate how the code relates to the size of the orifice.

Welding Regulators

Oxygen Regulator





Acetylene Regulator

STUDENT ACTIVITIES

1. a. Inspect a welding gas pressure regulator.

   b. Colour in the hose outlet fittings on the welding gas pressure regulators diagram to show the actual hose colour.

2. Mark each fitting thread direction as either RH (right hand) or LH (left hand) on the diagram.

3. On the diagram, write in the actual numbers on each gauge face according to the regulator gauge faces in a shop.

4. On the diagram, lightly shade in any colour zones, such as red warning zones, to match what you see on the actual regulator. Not every gauge face will have these colour zones.

OXYACETYLENE SAFETY

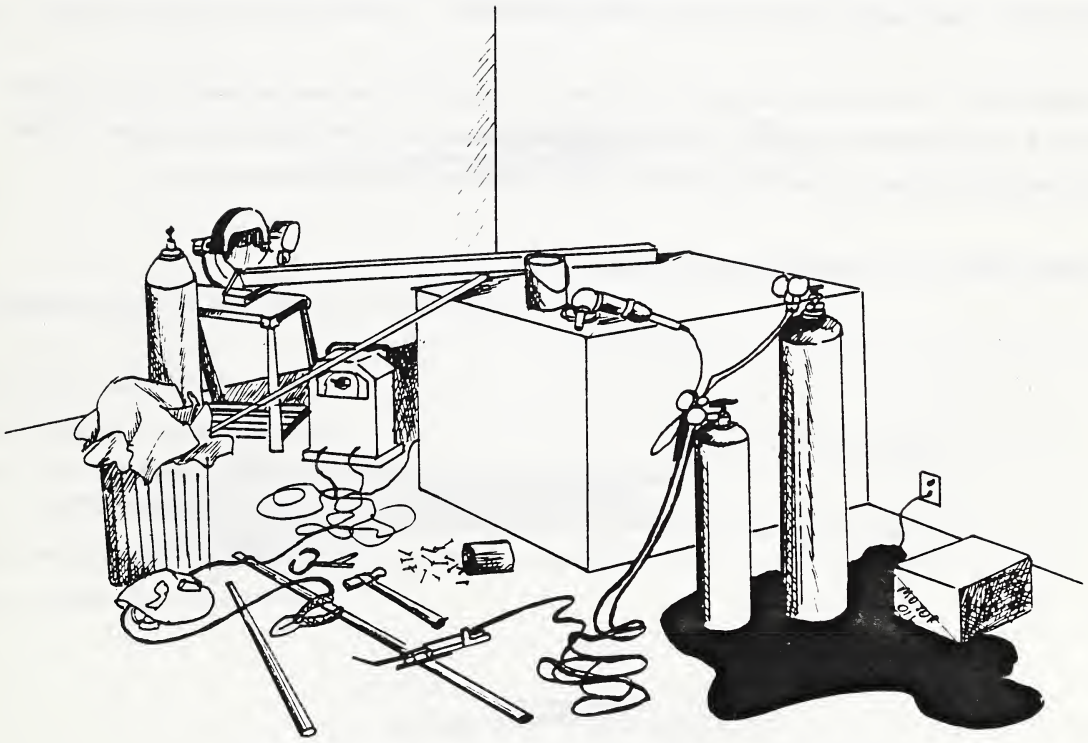
The equipment used for oxyacetylene welding can be very dangerous. The following safety rules protect the welder, and others, from accidents and possible injury. They also prevent damage to the equipment.

- Always wear safety goggles, gloves and protective clothing.
- Have a fire extinguisher available.
- Support oxygen and acetylene cylinders in an upright position so they cannot be tipped over.
- Blow out the cylinder valves in order to remove dust and dirt that may damage regulators.
- Release the pressure adjusting screw on the regulator before opening the cylinder valve.
- Stand to the side of regulator, keeping the cylinder valve between the operator and the regulator while opening the cylinder valve.
- Open all cylinder valves slowly.
- Do not use acetylene at pressures higher than 100 kPa.
- Purge the oxygen and acetylene lines individually before lighting the torch.
- Light the acetylene before opening the oxygen torch valve.
- Never use oil or grease on regulators, torches or fittings.
- Test connections for leaks, using soapsuds, paintbrush and water.
- Avoid lighting a torch, or welding near combustible material.
- Always operate the torch in a well-ventilated area.
- Place steel caps on all gas cylinders when they are being moved or stored, to protect the valves.
- Shut off the cylinder valves when not in use.
- Never cut or weld near concrete.
- Always weld or cut at least five feet from a pressurized gas cylinder.
- Always protect hoses from hot metal sparks or other physical damage.
- Never leave a burning torch unattended.

Note: Your teacher/supervisor will explain and demonstrate how each of these safety rules is to be followed.

STUDENT ACTIVITIES

1. Keeping the shop area safe is part of the accident prevention process. The picture on the next page shows a shop area that could be made safer. Discuss how this shop could be improved to prevent accidents. After the discussion, record the ideas generated for improvement.


MOTOR OIL

GAS WELDING TERMS

The following terms are commonly used in welding.

BACKFIRE: Momentary burning back of the flame into the tip. The flame goes out with a loud snap or pop. This is a **dangerous** condition, and should be reported to the teacher or supervisor.

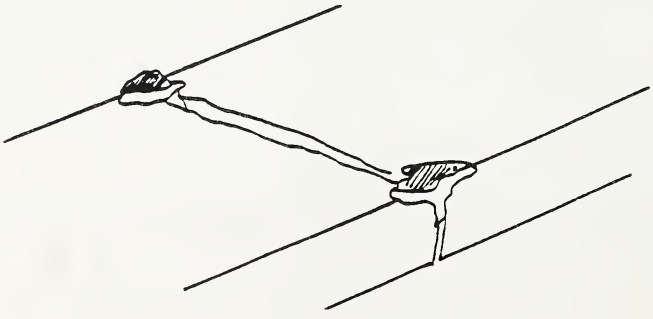
BASE METAL: The metal to be welded.

COUPON: Metal pieces used to practise welding operations.

FLASHBACK: A fire inside the torch. A hissing or squealing sound can be heard if this happens. This is a **very dangerous** condition. If this should happen in your unit, shut off the oxygen cylinder valve and the fuel gas cylinder valve and then report possible flashback to the teacher.

INNER CONE: The inner white part of a flame.

TACK WELD: A short weld used to hold a metal part in place for a short time.



TYPES OF FLAMES

There are three types of flames produced by an oxyacetylene torch: carburizing, oxidizing and neutral flames.

Carburizing flame has the following characteristics:

- excess of acetylene gas in the flame
- recommended for welding cast iron, aluminum and for hard surfacing
- causes the metal to become brittle.

Oxidizing flame has the following characteristics:

- burns an excess of oxygen
- burns with a whistling sound
- has a short inner cone
- causes the metal to harden and become brittle
- may be used in brazing but not used for fusion welding
- provides the hottest flame.

Neutral flame has the following characteristics:

- burns equal parts of oxygen and acetylene
- has a sharp inner cone and no acetylene feature
- does not harden the metal.

JOB SHEET 44
SETTING UP AND TESTING AN OXYACETYLENE UNIT

EQUIPMENT, TOOLS AND SUPPLIES

- Oxygen cylinder
- Acetylene cylinder
- Oxygen regulator
- Acetylene regulator
- Welding hoses
- Cylinder wrench
- Cylinder truck
- Water container
- Soapsuds
- Paintbrush
- Torch body
- Tip selection guide
- Welding gloves
- Safety glasses
- Protective clothing

PROCEDURE

1. **Put on the protective clothing, safety glasses and welding gloves.**

2. **Install and lock the cylinders in a vertical position in the cylinder truck.**

3. Remove the caps from the cylinders.

4. Blow out the valves of each cylinder, then quickly re-close valves.
   Caution: Stand away from the discharge opening when cracking the valves.

5. Connect the oxygen regulator to the oxygen cylinder.

6. Connect the acetylene regulator to the acetylene cylinder.

7. Turn the adjusting screws on both regulators counterclockwise until tension in the springs is released.

8. Connect the hoses to the regulators.

9. Open the oxygen cylinder valve all the way.

10. Open the acetylene valve $\frac{1}{4}$ to $\frac{1}{2}$ turn.

11. Purge each hose by turning the regulator adjusting screw clockwise until gas flows through the hose. Then turn back the regulator adjusting screw counterclockwise to stop the gas flow.
    Note: Purging removes foreign material from the hoses and torch.

12. Connect the torch body to the oxygen and acetylene hoses. Close both valves on the torch body.

13. Attach the welding tip to the torch body.

14. Turn the adjusting screw on the oxygen regulator clockwise until the correct working pressure is reached.

15. Turn the adjusting screw on the acetylene regulator clockwise until the correct working pressure is reached.
    Caution: Do not exceed 14 psi.

16. Using the soapsuds and water solution, test all connections for leaks as follows.

    - Using a clean paintbrush, apply soapsuds to all connections.
    - If any bubbles occur, indicating leaks, notify your teacher/supervisor.

17. Close the acetylene cylinder valve.

18. Close the oxygen cylinder valve.

19. Open the acetylene valve on the torch.

20. Close the acetylene valve on the torch when gauges reach zero.

21. Release the adjusting screw on the acetylene regulator by turning it counterclockwise.

22. Open the oxygen preheat valve on the torch.

23. Close the oxygen preheat valve on the torch when gauges reach zero.

24. Release the adjusting screw on the oxygen regulator by turning it counterclockwise.

25. Close the oxygen valve on the torch body.

26. Hang the torch and hose on the hanger bracket provided.

27. Return the oxyacetylene welding unit to its proper storage area.

28. Clean up the work area.

29. Using the following chart as a guide, evaluate your performance.

	Excellent 4	Very Good 3	Good 2	Not Acceptable 1
The proper equipment, tools and supplies were selected.				
All steps in the procedure were completed.				
All safety precautions were observed.				
The unit was assembled correctly.				
No leaks were present.				
The pressures were balanced.				
All related safety precautions were demonstrated.				
The equipment, tools and supplies were cleaned and returned to their proper storage areas.				
The work area was cleaned up.				

JOB SHEET 45
LIGHTING, ADJUSTING AND SHUTTING DOWN A TORCH

EQUIPMENT, TOOLS AND SUPPLIES

- Oxygen cylinder
- Acetylene cylinder
- Hoses
- Oxygen and acetylene regulators
- Torch body and welding tips
- Welding melt cart
- Flint lighter
- Welding gloves
- Welding goggles
- Protective clothing

PROCEDURE

1. **Put on the protective clothing and welding gloves.**

2. Check all cylinder, regulator and torch valves to make sure they are turned off.

3. Open the acetylene cylinder valve $\frac{1}{4}$ to $\frac{1}{2}$ turn.

4. Open the acetylene torch valve one turn to purge the line.

5. Turn the acetylene regulator pressure adjusting screw clockwise until the desired working pressure is reached.
   Note: The working pressure is decided by the size of the tip.
   Caution: Do not exceed 14 psi.

6. Close the acetylene torch valve.

7. Open the oxygen cylinder valve slowly all the way, and tighten in the open position.

8. Open the oxygen torch valve one turn.

9. Turn the oxygen regulator pressure adjusting screw clockwise until the desired pressure is reached. The working pressure is determined by the size of the tip.

10. Close the oxygen torch valve.

11. **Put on the welding goggles.**

12. Open the acetylene torch valve $\frac{1}{4}$ turn.

13. Light the torch with the flint lighter and adjust the valve until the smoke on the flame clears.

14. Open and adjust the oxygen torch valve to a neutral flame.

15. Produce a carburizing flame by reducing the supply of oxygen. Slowly close the oxygen torch valve until an inner feather is produced in the flame.

16. Produce an oxidizing flame by increasing the supply of oxygen. Slowly open the oxygen torch valve until a short, white inner cone is produced.

17. Close the acetylene torch valve.

18. Close the oxygen torch valve.

19. Close the acetylene cylinder valve.

20. Close the oxygen cylinder valve.

21. Open the acetylene torch valve. When gauges reach 0, turn back the acetylene regulator pressure adjusting screw until loose and then close the torch valve.

22. Open the oxygen torch valve. When the gauges reach 0, turn back the oxygen regulator pressure adjusting screw until loose and then close the torch valve.

23. Roll up the welding hoses.

24. Place the torch and hoses on the hanger bracket.

25. Return the welding unit to its proper storage area.

26. Clean up the work area.

27. Using the following chart as a guide, evaluate your performance.

	Excellent 4	Very Good 3	Good 2	Not Acceptable 1
The proper equipment, tools and supplies were selected.				
All steps in the procedure were completed.				
All safety precautions were observed.				
The flame was safely lit.				
All flame types were demonstrated.				
The flame was safely extinguished.				
The unit was properly shut down.				
All related safety precautions were demonstrated.				
The equipment, tools and supplies were cleaned and returned to their proper storage areas.				
The work area was cleaned up.				

BRAZE WELDING

When braze welding, the base metal is heated but not melted. A bronze filler rod is used to deposit a bead over the joint. The cooled bronze bead acts like a glue to hold the parts together.

One way to recognize braze welding is to compare it to fusion welding. The differences between these two are:

- **Braze Welding:**
  - the base metal is not melted
  - a bronze alloy filler rod is used.

- **Fusion Welding:**
  - the base metal is melted and the filler rod material is mixed in
  - a filler rod with characteristics similar to the base metal is used.

Before brazing, the bead surface is often prepared by tinning. The flow of the thin film of bronze is known as tinning. The bronze filler rod and metal surface must be heated to just the right temperature to get proper tinning.

- If too hot, the bronze will boil, form little balls and, accompanied by a hissing sound, turn light blue.

- If too cool, the molten bronze will form into drops rather than flow evenly over the surface.

- If the temperature is correct, the molten bronze will spread evenly and thinly.

ADVANTAGES OF BRAZE WELDING

- The characteristics of the base metal are not changed because the metal is not heated to a molten state.
- Less heat is applied to the object being welded.
- Less gas is used during welding.
- Brazing can be used on thin metals with less chance of burn through.
- Brazing can be used on malleable castings.
- It takes less time to form braze welds.
- Different kinds of metals can be braze welded together.

DISADVANTAGES OF BRAZE WELDING

- Brazing cannot be used on metals where high strength is required.
- Bronze is expensive.
- Braze welds should not be used on items that will be exposed to very high heat.
- Sometimes the properties of the bronze metal and the base metal differ, creating corrosion problems.
- The surfaces must be well cleaned to achieve proper bonding.

PREPARING FOR BRAZING

Before braze welding, it is important to have a chemically clean metal surface. This helps the molten bronze stick to the base metal. A clean surface allows the bronze to flow smoothly and evenly over the area being welded and is required to make a strong bond.

Cleaning the metal surface can be done by:

- mechanical means – using a wire brush or a grinder
- chemical means – using flux.

To clean the metal completely, the mechanical cleaning method should be combined with the use of flux.

FLUX

The flux is a chemical which:

- cleans the metal
- prevents oxidation of the filler metal
- increases the flow of filler metal
- permits the filler metal to penetrate the pores of the base metal
- is available in separate containers or as a rod coating.

JOB SHEET 46
BRAZE WELDING A BUTT JOINT

EQUIPMENT, TOOLS AND SUPPLIES

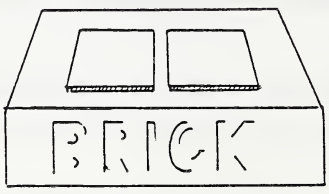
- Oxyacetylene welding unit
- Welding gloves
- Welding goggles
- Protective clothing
- Welding tip
- Wire brush
- Pliers
- Flint lighter
- Firebrick
- Two, mild steel coupons 2 mm thick, 3.5 cm × 15 cm
- Bronze filler rod, flux coated
- Quench tank

PROCEDURE

1. **Put on the protective clothing, welding goggles and welding gloves.**

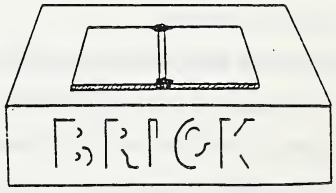
2. Clean the joint surfaces with the wire brush.

3. Position the metal coupons as illustrated.



4. Light and adjust the torch to a neutral flame.

5. Heat the coupon corners at one end of the joint to cherry red.



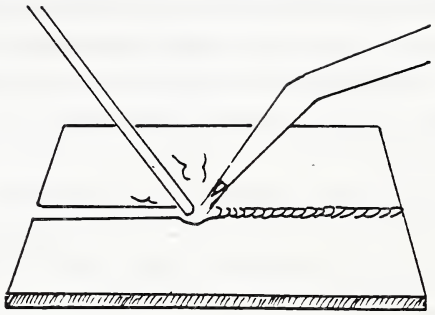
6. Touch the filler rod to the hot metal to tin the tack area.
   Note: The coating on the rod produces the required flux.

7. Tack the metal coupons in place by building up a small lump of filler metal at the end of the joint.

8. Tack the other end of the joint.

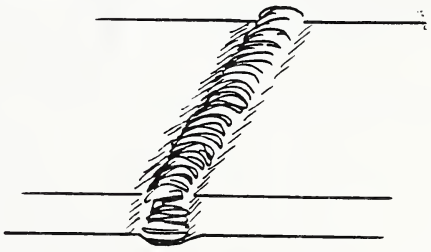
9. Heat the surface of the weld area to red hot.

10. Hold the torch at approximately 45° vertically and position the filler rod at the same angle in the opposite direction.



11. When a cherry red colour occurs, melt a small amount of bronze rod onto the surface and spread it along the entire seam with the heat of the flame. Use more brazing rod material to finish the tinning if required.

12. Heat the joint at one end and lay a bead along the length of the joint. Keep the area red hot. Touch the brazing rod into the puddle and draw it out in the direction of the unwelded joint.



13. Shut down the welding unit.

14. Pick up the coupons with the pliers and cool off the joint in the quench tank.

15. Clean and return all equipment, tools and supplies to their proper storage areas.

16. Clean up the work area.

17. Using the following chart as a guide, evaluate your performance.

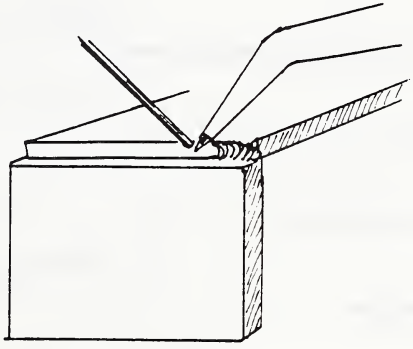
	Excellent 4	Very Good 3	Good 2	Not Acceptable 1
The proper equipment, tools and supplies were selected.				
All steps in the procedure were completed.				
The torch was properly lit and adjusted.				
The bead surface was smooth and consistent.				
The weld penetrated to the other side.				
The base metal was not damaged.				
All related safety precautions were demonstrated.				
The equipment, tools and supplies were cleaned and returned to their proper storage areas.				
The work area was cleaned up.				

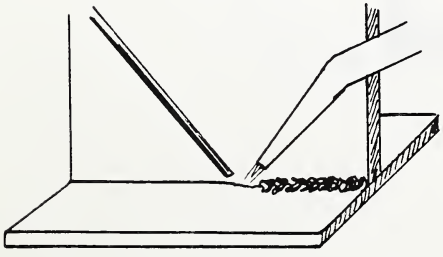
BRAZING TECHNIQUES

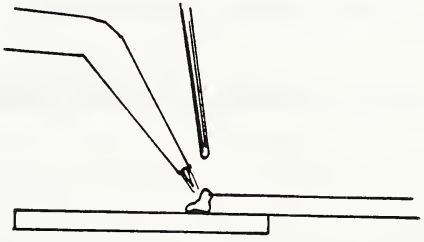
When brazing, it is important to remember that:

- thick materials absorb more heat, therefore a larger tip and slower speed is required
- thin materials will burn through easily, so small diameter rods and less heat is required. Carefully monitor the material and adjust the speed and applied heat accordingly
- to make the brazing material flow in a certain direction, heat the material in that direction
- to check for penetration, check the unwelded side of the joint to see if the molten bronze has travelled completely through the joint.

Different joints and proper torch positions are illustrated below.







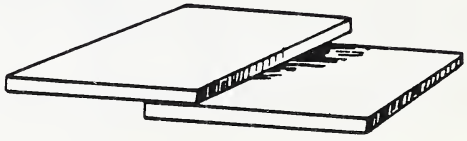
JOB SHEET 47
BRAZE WELDING A LAP JOINT

EQUIPMENT, TOOLS AND SUPPLIES

- Oxyacetylene welding unit
- Welding gloves
- Welding goggles
- Protective clothing
- Welding tip
- Wire brush
- Two mild steel coupons, 3.5 cm × 15 cm, 3.2 mm thick
- Bronze filler rod, flux coated
- Flint lighter
- Firebrick
- Pliers
- Quench tank

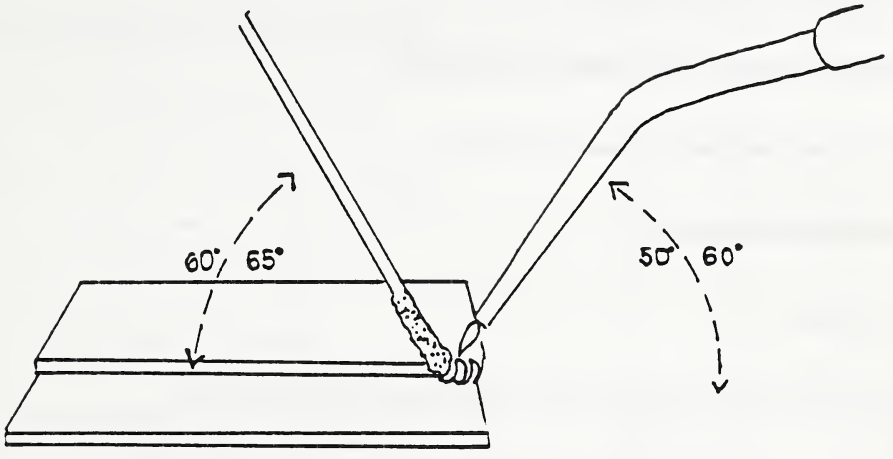
PROCEDURE

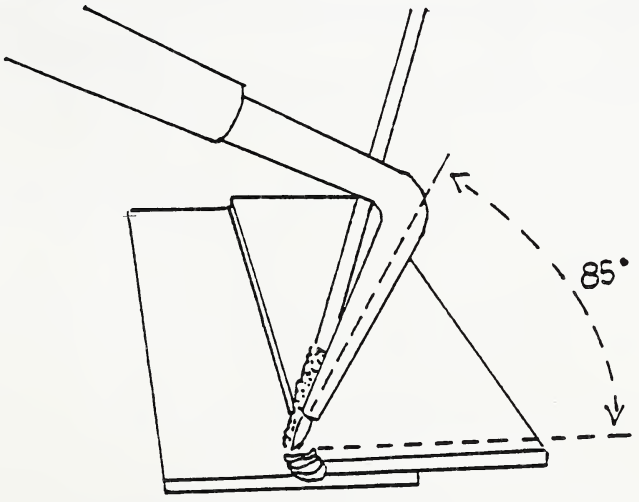
1. **Put on the protective clothing and welding gloves.**
2. Clean the joint surfaces.
3. Position the coupons as illustrated.



4. **Put on the welding goggles.**
5. Light the torch and adjust to a neutral flame.
6. Tin both ends of the joint on one side.
7. Tack both ends of the joint on one side.
8. Preheat the joint and tin the joint on the top side.

9. Hold the torch and filler rod as illustrated.





10. Lay a bead along the joint. The bead must be thick enough to fill in the joint corner and overlap the surfaces. Use sufficient heat to allow the filler metal to flow through the joint.

11. Shut down the torch when the joint is complete.

12. Cool off the coupon and inspect the joint for penetration.

13. Clean the joint surface on the other side of the coupons.

14. Reposition the coupons with the grazed joint down.

15. Lay a brazed bead along the joint.

16. Shut down the torch.

17. Pick up the coupons with the pliers and cool off the joint in the quench tank.

18. Clean and return all equipment, tools and supplies to their proper storage areas.

19. Clean up the work area.

20. Using the following chart as a guide, evaluate your performance.

	Excellent 4	Very Good 3	Good 2	Not Acceptable 1
The proper equipment, tools and supplies were selected.				
All steps in the procedure were completed.				
The torch was properly lit and adjusted.				
The bead surface was smooth and consistent.				
The weld penetrated to the other side.				
The base metal was not damaged.				
All related safety precautions were demonstrated.				
The equipment, tools and supplies were cleaned and returned to their proper storage areas.				
The work area was cleaned up.				

FUSION WELDING

Fusion welding joins metal to metal. The edges of the joint are heated to the melting point. The melted edges are allowed to mix together and then cooled. The following factors will affect fusion welding: penetration, weld quality, tip size, filler rod selection.

PENETRATION is the depth from the original surface of the base metal to the point at which fusion ends. Without proper penetration, the weld will lack strength.

WELD QUALITY refers to the strength of the weld. A high quality weld will not have flaws or 'faults'. Weld quality is affected by:

- flame adjustment
- angle of the tip
- distance from the work
- speed of travel
- movement of the tip.

TIP SIZE is important to good welding. The correct tip size depends on:

- the thickness of the metal
- the size of the welding rod.

Equipment manufacturers provide tip selection charts with gas welding units. These charts are used to aid in choosing the proper tip size for each job.

FILLER ROD adds strength to the weld or joint. When selecting a filler rod, consider:

- a rod with properties similar to those of the base metal
- the thickness of the metal.

JOB SHEET 48
PRACTISING HEAT CONTROL

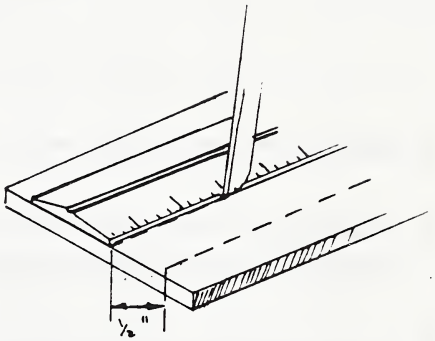
EQUIPMENT, TOOLS AND SUPPLIES

- Oxyacetylene welding unit
- Welding tip
- Welding gloves
- Welding goggles
- Protective clothing
- Pliers
- Mild steel coupons 3 cm × 7 cm, 16 gauge
- Quench tank
- Wire brush
- Flint lighter
- Firebrick

PROCEDURE

1. **Put on the protective clothing and welding gloves.**

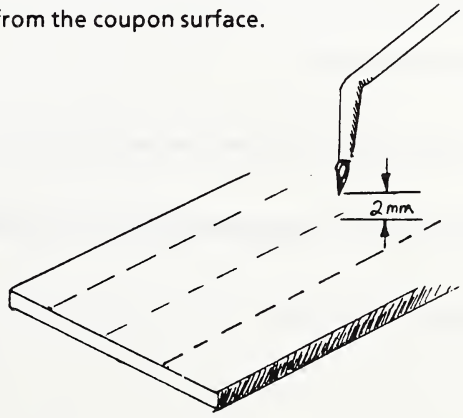
2. Draw guidelines on the coupons as illustrated.



3. Set the oxyacetylene working pressures according to manufacturer's recommendations.

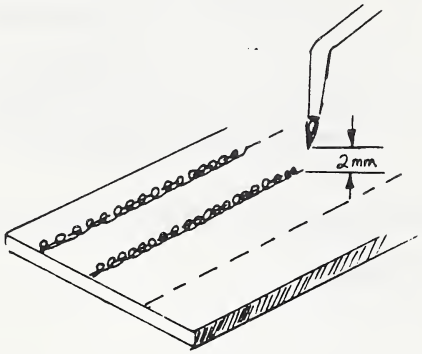
4. Light and adjust the torch to a neutral flame.

5. Position the inner cone about 2 mm to 3 mm from the coupon surface.



6. Hold the tip at a 30° to 45° angle from vertical.

7. Move the torch tip in small circles to create the penetration.

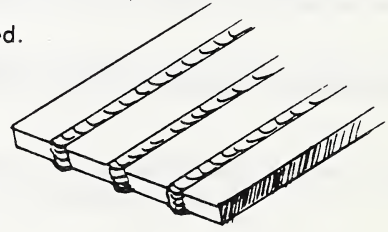


8. Begin to move along the joint when a molten puddle is established.

9. Move the torch slowly and constantly to get maximum penetration. The puddle should sink on the other side without burning through.

10. Make a second pass down the plate, parallel to the first.

11. Continue practising until uniform, maximum penetration throughout the pass is achieved.



12. Shut down the torch.

13. Pick up the coupon with the pliers and plunge it in the quench tank.

14. Clean and return all equipment, tools and supplies to their proper storage areas.

15. Clean up the work area.

16. Using the following chart as a guide, evaluate your performance.

	Excellent 4	Very Good 3	Good 2	Not Acceptable 1
The proper equipment, tools and supplies were selected.				
All steps in the procedure were completed.				
The passes were properly laid out.				
The torch was properly lit and adjusted.				
The passes followed the lines.				
On the last pass: • the penetration was consistent • the plate was not burned through • penetration was maximized.				
All related safety precautions were demonstrated.				
The equipment, tools and supplies were cleaned and returned to their proper storage areas.				
The work area was cleaned up.				

JOB SHEET 49
WELDING A FUSION JOINT

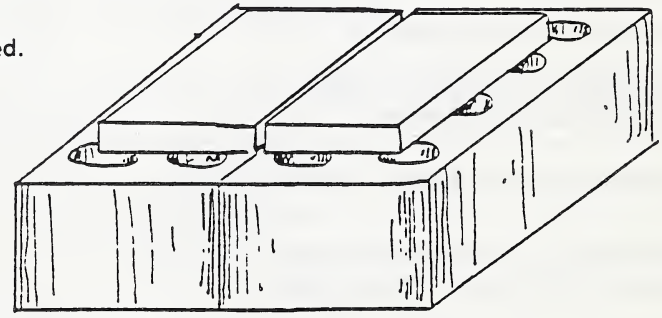
EQUIPMENT, TOOLS AND SUPPLIES

- Oxyacetylene welding unit
- Welding tip
- Welding gloves
- Welding goggles
- Protective clothing
- Two mild steel coupons, 16 gauge, 3 cm × 7 cm
- Flint lighter
- Firebrick
- Pliers
- Quench tank

PROCEDURE

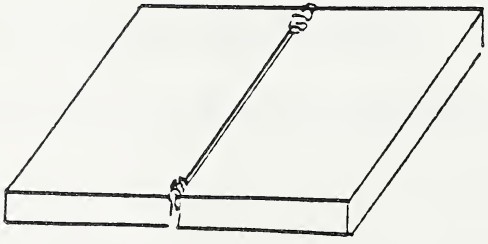
1. **Put on the protective clothing and welding gloves.**

2. Position the coupons as illustrated.

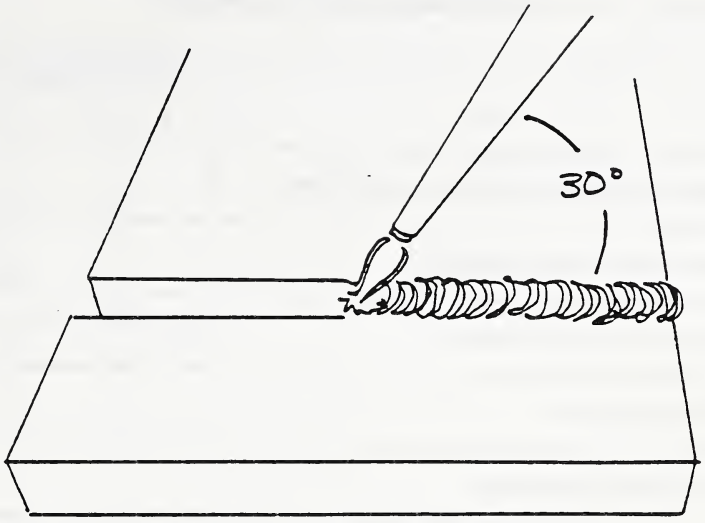


3. Light and adjust the torch to a neutral flame.

4. Tack either end of the joint by melting the coupon corners together.



5. Hold torch at 30° to 45° from vertical.



6. Position the inner cone about 2 mm to 3 mm from the surface of the metal and move in small circles.

7. Move the puddle forward with the flame and allow the puddle to travel along the joint.

8. When the edge of the joint is reached, add slightly more filler rod to maintain the bead size and shape.

9. Shut down the torch.

10. Pick up the coupon with the pliers and cool off the joint in the quench tank.

11. Clean and return all equipment, tools and supplies to their proper storage areas.

12. Clean up the work area.

13. Using the following chart as a guide, evaluate your performance.

	Excellent 4	Very Good 3	Good 2	Not Acceptable 1
The proper equipment, tools and supplies were selected.				
All steps in the procedure were completed.				
The torch was properly lit and adjusted.				
The weld width was consistent.				
The weld penetration was maximized.				
The plate(s) were not burned through.				
The joint's strength was acceptable.				
All related safety precautions were demonstrated.				
The equipment, tools and supplies were cleaned and returned to their proper storage areas.				
The work area was cleaned up.				

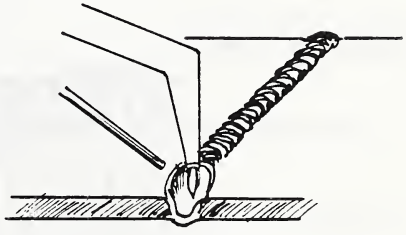
JOB SHEET 50
WELDING WITH A FILLER ROD

EQUIPMENT, TOOLS AND SUPPLIES

- Oxyacetylene unit
- Striker
- Welding gloves
- Welding goggles
- Protective clothing
- Steel filler rod of recommended size
- Two thin steel coupons, 3 cm × 7 cm
- Firebrick
- Pliers
- Quench tank

PROCEDURE

1. **Put on the protective clothing, welding gloves and welding goggles.**
2. Set up the coupons in a butt or lap joint on the firebrick.
3. Light and adjust the torch.
4. Tack the coupons at both ends.
5. Heat one end of the joint to get a good puddle for penetration and dip the filler rod into the puddle. Draw the rod out, away from the torch.
6. Continue working down the joint to form a uniform bead with good penetration.
7. Shut down the torch properly.
8. Pick up the coupons with the pliers and cool it in the quench tank.
9. Clean and return all equipment, tools and supplies to their proper storage areas.
10. Clean up the work area.



11. Using the following chart as a guide, evaluate your performance.

	Excellent 4	Very Good 3	Good 2	Not Acceptable 1
The proper equipment, tools and supplies were selected.				
All steps in the procedure were completed.				
The torch was properly lit and adjusted.				
The bead was of uniform width.				
The bead penetration was maximized.				
The plate(s) were not burned through.				
The joint's strength was acceptable.				
All related safety precautions were demonstrated.				
The equipment, tools and supplies were cleaned and returned to their proper storage areas.				
The work area was cleaned up.				

DISCUSSION TOPICS

1. What tasks would require that gas welding skills be used?

2. How hot is molten steel?

3. How hot is an oxyacetylene flame?

FLAME CUTTING

Welding equipment can be used to cut metal. Oxyacetylene cutting is used to cut ferrous metals. A high temperature and the chemical reaction of oxygen with the base metal results in the metal being cut.

OXYACETYLENE CUTTING TERMS

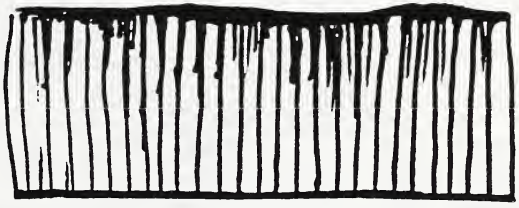
- The **SLAG** is the waste product of cutting. It contains pieces of iron and some ashes.

- A **SLAG BOX** is a metal container which catches the slag during cutting. It contains a layer of sand or water. The purpose of the slag box is to:

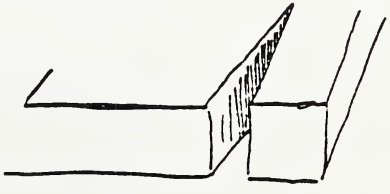
  - catch the hot slag
  - prevent fires
  - protect clothing
  - protect the welding hoses.

- **OXIDIZATION** is the process of combining oxygen with something else. Rusting is an example of metal combining with oxygen. Rust is the product of oxidizing. An example of rapid oxidization is oxyacetylene cutting.

- **DRAGLINE** refers to the lines on the surface of the cut. These lines are caused by flame movement.

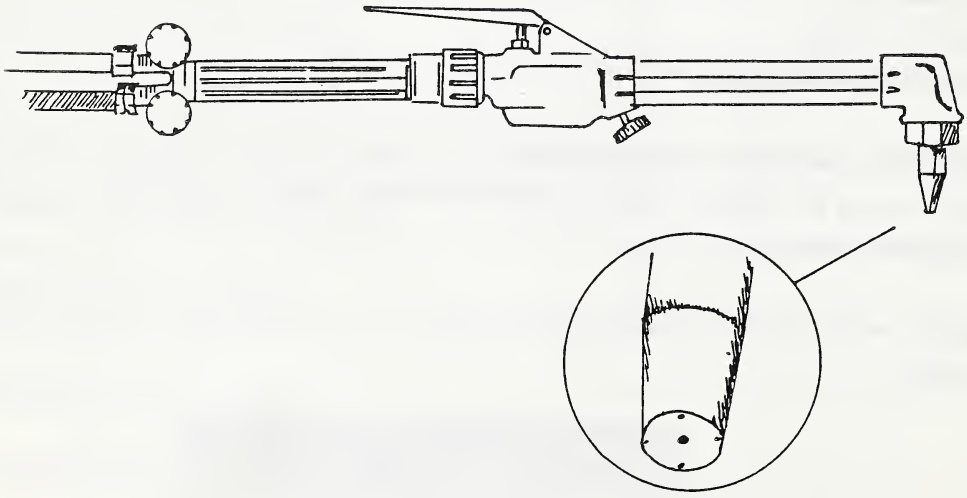


- **KERF** is the area where the metal was removed during the cutting.



CUTTING EQUIPMENT

The equipment used for cutting metal is the same as that used for oxyacetylene welding except for the torch tip. The welding tip is removed and a cutting attachment is screwed onto the torch body. The following illustration shows the features of a cutting attachment.



Features of a Cutting Tip

The PREHEAT ORIFICE preheats the metal to the kindling point. The metal is a cherry red colour at the kindling point.

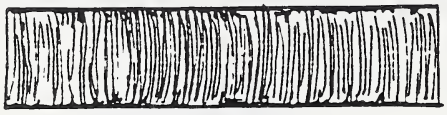
The CUTTING ORIFICE releases a stream of oxygen that removes the oxidized metal.

Different tips are available for different cutting operations. Tip size is determined by the thickness of metal to be cut and the speed of cutting. Manufacturers of welding equipment make selection charts for tip sizes.

EVALUATING CUTS

Properly made metal cuts are required for project fabrication and repairs. To achieve a quality cut, the torch must be properly adjusted and the proper technique and speed used.

The following illustration shows a properly made cut. The edge is square and the draglines are vertical and not too obvious.



The following illustrations may be used as a guide when diagnosing cutting problems.

- Preheat flames were too small and the cutting speed was too slow. This caused bad gouging at the bottom of the cut.

- The preheat flames were too long. The top surface has melted over forming an irregular cut edge and surface slag.

- The oxygen pressure was too low. The top edge melted over because a slow cutting speed was required.

- The oxygen pressure was too high and the nozzle size too small. Control of the cut was difficult, forming a rough surface.

- The cutting speed was too slow. The irregular drag lines are clues to this problem.

- The cutting speed was too high. This caused a break to the drag line and an irregular edge.

- Torch handling was unsteady. This caused the cut surface to be wavy and irregular.

JOB SHEET 51
PRACTISING FLAME CUTTING

EQUIPMENT, TOOLS AND SUPPLIES

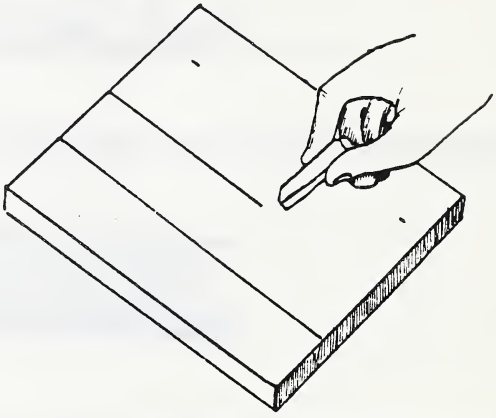
- Oxyacetylene unit
- Striker
- Ruler
- Pliers
- Soapstone
- Welding gloves
- Welding goggles
- Protective clothing
- Quench tank
- Firebrick
- Mild steel coupon, 6 mm thick

PROCEDURE

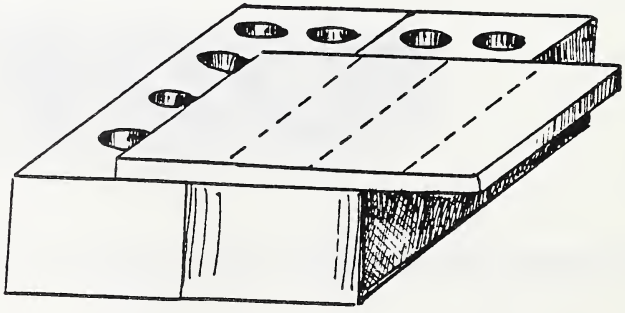
Caution: The cutting area must be clear of all flammable waste.

1. **Put on the protective clothing.**

2. Draw lines across the coupon as illustrated.



3. Position the coupon on the firebrick as illustrated.



4. **Put on the welding gloves and welding goggles.**

5. Adjust the working pressures as recommended.

6. Open the torch acetylene valve $\frac{1}{4}$ turn.

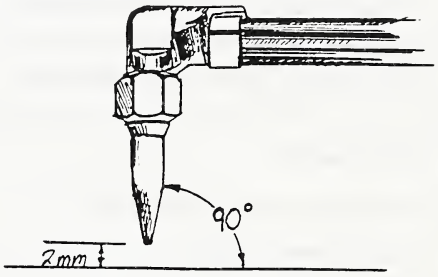
7. Light the acetylene torch and adjust the flame until the smoke disappears.

8. Open the torch oxygen valve all the way.

9. Open the oxygen preheat valve and adjust the flame to neutral.

10. Position the torch tip as illustrated.

    Note: Right-handed people will normally find it easier to travel from right to left.



11. Form a molten puddle on the surface of the steel plate.

12. Press the oxygen cutting lever and move the torch along the line. Adjust the speed of travel until a clean cut is formed.

13. Shut off the torch and place it where it cannot fall.

14. Using the pliers, reposition the HOT plate to cut the next section.

15. Relight the torch and repeat the process until the plate is completely cut up.

16. Shut down the unit properly.

17. Pick up all the hot metal pieces and cool them off in the quench tank.

18. Clean and return all equipment, tools and supplies to their proper storage areas.

19. Clean up the work area.

20. Using the following chart as a guide, evaluate your performance.

	Excellent 4	Very Good 3	Good 2	Not Acceptable 1
The proper equipment, tools and supplies were selected.				
All steps in the procedure were completed.				
The torch was properly lit and adjusted.				
The torch tip was properly positioned.				
On the last cut: • the edge surface was smooth • the cut was straight				
All related safety precautions were demonstrated.				
The equipment, tools and supplies were cleaned and returned to their proper storage areas.				
The work area was cleaned up.				

DISCUSSION TOPICS

1. What automotive service work would require flame cutting skills?

2. What hazards are associated with flame cutting in an automotive shop?

WORK STANDARDS AND MANAGEMENT

The major tasks of workers in any industry are to provide quality service and maintain proper relationships with clients and other workers. To achieve these goals, every supervisor has expectations that workers will be able to meet certain standards. These standards include:

1. **Personal Standards**
   - Is punctual
   - Shows initiative
   - Practises personal hygiene
   - Is well groomed
   - Is self-directed
   - Remains on task
   - Demonstrates an acceptable level of accuracy

2. **Regulatory Standards**
   - Knows and follows safety regulations
   - Maintains work area
   - Recognizes vehicle safety standards

3. **Materials-Use Standards**
   - Demonstrates safe-use practices
   - Cares for and maintains equipment and tools
   - Uses supplies with care
   - Uses shop reference material

4. **Interpersonal Standards**
   - Demonstrates respect for property
   - Shows respect for others
   - Has a positive attitude to work
   - Has a pleasant personality

Throughout the course you will be evaluated on how well you are meeting these standards.

To help you identify the standards expected of you during this course, evaluate yourself using Appendix 3: Work Standards and Management Monthly Evaluation Chart.

At the end of each month, make a copy of the chart and evaluate your performance. Check each evaluation against previous evaluations and note the improvements.

GLOSSARY

Asbestos	A natural material that is heat resistant but has been identified as a carcinogen.
Backfire	A dangerous burning back of a welding flame into a tip.
Base metal	The original metal that is welded on.
Body	The parts of a vehicle that provide the external shape, passenger compartment and cover the power train and chassis.
Carcinogen	A cancer causing substance or material.
Chassis	The metal framework that supports the rest of a vehicle.
Component	A part of a vehicle.
Coupon	A small metal piece used for welding practice.
Fasteners	Any item used to hold two or more parts together.
Flashback	A welding flame that is actually burning inside the tip. This is a very dangerous condition.
Inner cone	The innermost part of a welding flame.
Power train	The parts of a vehicle used to propel it down the road.
Tack weld	A small weld used to secure a metal part in position.
Work order	A multiple copy form that is used for communicating service and repair requests. It includes the description of the vehicle, any customer requests and permission acknowledgements.

AUTOMOTIVE SERVICES 26
PROFILE

JOB SCOPE	1 Locates local automotive service job openings	2 Explains common automotive service industry terminology		
EQUIPMENT, TOOLS AND SUPPLIES IDENTIFICATION	1 Identifies required equipment, tools and supplies	2 Identifies micrometers with metric or imperial scales	3 Identifies fastener types and uses	
VEHICLE PARTS IDENTIFICATION	1 Names general automotive parts	2 Locates given component on different models of vehicles	3 Identifies and defines tire codes	4 Recognizes and makes a diagnosis of tire wear patterns
	5 Locates tire inflation specification on vehicle	6 Identifies brake system components on different vehicles	7 Locates vehicle lubrication points	
ENGINES AND ENGINE SYSTEMS IDENTIFICATION	1 Locates components of engine support systems on different vehicles	2 Describes purpose(s) of each engine support system	3 Lists part movements and purpose for each stroke of the four-stroke cycle	4 Identifies fuel system components
	5 Traces fuel flow through fuel system	6 Defines selected automotive terminology		
ENGINE SUPPORT SYSTEMS	1 Operates shop tools and equipment in a proper, safe manner	2 Locates service information in shop reference materials	3 Raises vehicles with shop lifting equipment	4 Supports a vehicle on safety stands
	5 Performs a compression test and a diagnosis of results	6 Performs a vacuum test and a diagnosis of results	7 Performs a cooling system pressure test and a diagnosis of results	8 Performs an oil pressure test and a diagnosis of results
	9 Looks up parts information	10 Inventories equipment, tools and supplies	11 Measures dimensions with micrometers to acceptable accuracy	12 Measures dimensions with calipers to acceptable accuracy
	13 Lists proper measuring tool practices			

AUTOMOTIVE SERVICES 26
PROFILE (continued)

REPLACEMENT SERVICES	1 Replaces fuel filters	2 Removes and replaces brake shoes	3 Removes and replaces a tubeless tire	4 Follows service manuals to replace complete major components
	5 Removes and replaces disc pads	6 Changes engine oil and oil filter	7 Replaces cooling system hoses	8 Replaces automotive battery
	9 Replaces light bulbs	10 Changes fan belts	11 Changes wiper blades	
VEHICLE CLEANING	1 Details a vehicle to industry standards			
MECHANICAL SERVICES	1 Adjusts carburetor linkages and controls	2 Adjusts brakes	3 Bleeds brake hydraulics	4 Balances a tire
	5 Repairs tire leak	6 Properly inflates tires	7 Rotates a set of tires	8 Disassembles and reassembles a simple carburetor
WORK STANDARDS	1 Follows directions during maintenance and repairs	2 Wears required safety equipment	3 Connects exhaust pick-up hoses to tail pipe before running engine	4 Cleans and returns equipment, tools and supplies to proper storage area
	5 Cleans up work area after use	6 Observes and records standard fault-finding procedures	7 Cleans brakes safely before service work	8 Checks for pressure before servicing cooling systems
SUPPLY MANAGEMENT	1 Records items used on vehicle service work	2 Identifies local auto parts suppliers		
WORK AREA MANAGEMENT	1 Maintains a safe, clean work area	2 Maintains shop equipment	3 Identifies equipment and shop maintenance frequency	4 Records equipment maintenance requirements

MAJOR COMPONENT REMOVAL AND REPLACEMENT CHART

In this course, you will be given the opportunity to participate in changing the major parts of a vehicle. Time has not been allowed for overhaul of any parts; only removal and replacement is possible.

For each component, there is a section in your shop reference materials that describes the process step by step. You must follow these instructions carefully, and if you do not know how to do something, ask your teacher/supervisor. Failure to do tasks like a clutch replacement properly can be both dangerous and expensive.

The following chart is provided so you can record the work you have completed in this area.

Component	Date	Type of Vehicle
• Engine		
• Clutch		
• Standard Transmission		
• Automatic Transmission		
• Drive Shaft		
• Rear Axle Assembly		
•		

WORK STANDARDS AND MANAGEMENT
MONTHLY EVALUATION CHART

Name _____ Date _____	Evaluation	
	Satisfactory	Unsatisfactory
DEMONSTRATES APPROPRIATE WORK HABITS		
Is punctual		
Comes prepared to work		
Prepares immediately for work		
Performs duties as instructed, with acceptable accuracy		
Uses time productively		
Considers solutions to problems before asking for assistance		
FOLLOWS RULES AND REGULATIONS		
Follows acceptable safety and sanitation procedures		
Does not bring food or drink into the work area		
Dresses appropriately		
Uses equipment, tools and supplies as instructed		
Clears work area after use		
Performs required cleanup duties		
DEMONSTRATES CONCERN FOR SAFETY		
Demonstrates safety practices		
Maintains a safe and sanitary work area		
Wipes up spills immediately		
Does not leave work area without permission		
DEMONSTRATES PROFESSIONAL ATTITUDE		
Displays a professional appearance		
Is friendly and courteous		
Advises teacher/supervisor of hazards or necessary repairs		
Informs teacher/supervisor in advance of necessary absences		
Demonstrates responsibility for completion of assignments and tasks		
Follows verbal and written instructions		
Demonstrates an organized work approach		

Areas I want to improve for next month are:

_____

JOB SHEET EVALUATION CHART

Job Sheet	EVALUATION								
	Self			Classmate			Teacher/Supervisor		
	1	2	3	1	2	3	1	2	3
1. Collecting Automotive Job Advertisements									
2. Identifying Vehicle Parts									
3. Taking an Inventory									
4. Identifying Local Automotive Suppliers									
5. Using Shop Manuals									
6. Maintaining Equipment									
7. Measuring with Calipers									
8. Measuring with Micrometers									
9. Detailing a Vehicle									
10. Identifying Engine Components									
11. Identifying Engine Support System Components									
12. Tracing the Fuel System									
13. Locating Fuel Filters									
14. Changing an In-Line Fuel Filter									
15. Changing a Screw-on Fuel Filter									
16. Changing an In-Carburetor Fuel Filter									
17. Adjusting Curb Idle Speed									
18. Adjusting Fast Idle Speed									

JOB SHEET EVALUATION CHART (continued)

Job Sheet	EVALUATION								
	Self			Classmate			Teacher/Supervisor		
	1	2	3	1	2	3	1	2	3
19. Adjusting Idle Mixture Screws									
20. Investigating Modern Carburetor Adjustment									
21. Adjusting a Modern Carburetor									
22. Adjusting an Automatic Choke									
23. Investigating Carburetor Overhaul									
24. Disassembling and Reassembling a Simple Carburetor									
25. Adjusting Tire Inflation									
26. Performing a Tire Rotation									
27. Removing and Replacing Brake Shoes on a Simple Drum Brake Unit									
28. Removing and Replacing Brake Shoes on a Bendix Brake Unit									
29. Removing and Replacing Brake Shoes on a Delco Morraine Brake Unit									
30. Adjusting Rear Drum Brakes									
31. Bleeding the Brake Hydraulic System									
32. Removing and Replacing a Set of Disc Pads									
33. Taking a Compression Test									
34. Performing a Vacuum Test									
35. Pressure Testing a Cooling System									
36. Performing an Oil Pressure Test									

JOB SHEET EVALUATION CHART (continued)

Job Sheet	EVALUATION								
	Self			Classmate			Teacher/Supervisor		
	1	2	3	1	2	3	1	2	3
37. Changing the Engine Oil and Filter									
38. Replacing an Upper Radiator Hose									
39. Replacing a Fan Belt									
40. Replacing a Battery									
41. Replacing a Headlight									
42. Replacing a Signal Light Bulb									
43. Replacing Windshield Wiper Blades									
44. Setting Up and Testing an Oxyacetylene Unit									
45. Lighting, Adjusting and Shutting Down a Torch									
46. Braze Welding a Butt Joint									
47. Braze Welding a Lap Joint									
48. Practising Heat Control									
49. Welding a Fusion Joint									
50. Welding with a Filler Rod									
51. Practising Flame Cutting									

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